USAAEFA PROJECT NO. 84-11

# PRELIMINARY AIRWORTHINESS EVALUATION OF THE AH - 1S (MODERNIZED COBRA) WITH THE HELLFIRE, TOW, AND STINGER MISSILES INSTALLED

ROBERT MACMULLIN
MAJ, AV
PROJECT OFFICER/PILOT

GARY T. DOWNS
LTC, AV
PROJECT PILOT

EDWARD J. TAVARES
MAJ, AV
PROJECT PILOT

JOHN S. LAWRENCE
MAJ, AV
PROJECT ENGINEER

LOREN L. TODD
MAJ, AV
PROJECT ENGINEER

WALDO F. CARMONA
CPT, AV
PROJECT ENGINEER

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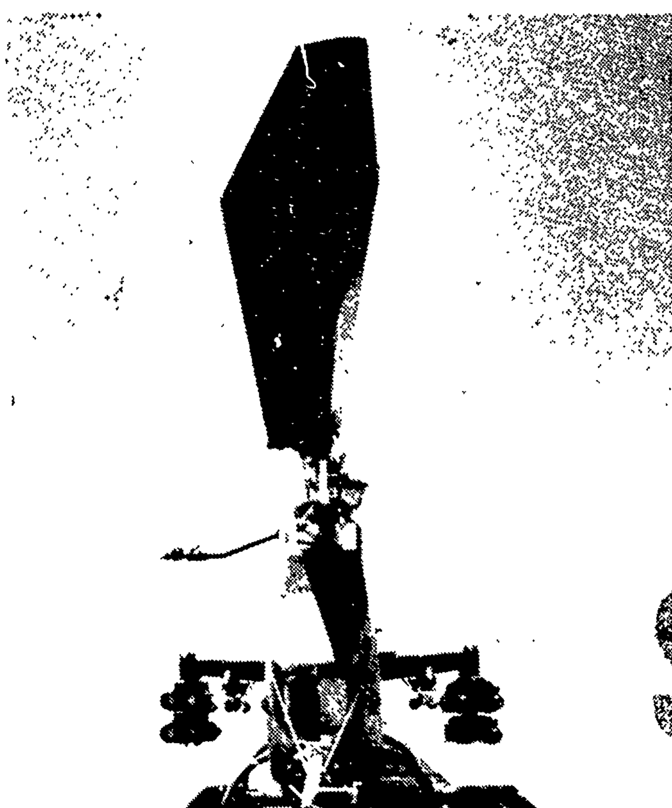





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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The US Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation of the AH-1S Modernized Cobra (S/N 69-16423) configured with the Hellfire, TOW, and Stinger Missiles installed in various combinations to obtain limited flight performance and flying qualities data prior to operational testing. Flight tests were performed at Edwards Air Force Base, California (elevation 2302 feet) and Bakersfield, California (elevation 488 feet) between 17 May and 27 July 1984. During the evaluation, 46 flights

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totaling 56.5 hours (39 productive) were conducted. The aircraft was operated at gross weights up to 10,400 lb, up to 11,340 feet density altitude and at a lateral center of gravity (cg) range from one inch right to approximately three inches left. The asymmetric loadings were caused by the various combinations of armament configurations. The change in equivalent flat plate area compared to the clean aircraft for each configuration varied as a function of airspeed. At 130 knots true airspeed (KTAS), the increased flat plate area was 4.2 square feet for the Launcher configuration, 4.8 square feet for the TOW configuration, 6.6 square feet for the Hellfire and Hellfire/TOW configurations, and 7.8 square feet for the Stinger/Hellfire/TOW configuration. The increase in flat plate area for the Stinger/Hellfire/TOW configuration reduced maximum level flight speed for normal rated power by approximately 8 KTAS. With the exception of the two armament related shortcomings listed below, the handling qualities and the reactions to system failures of the AH-1S (MC) were not significantly changed by the asymmetric loading of the various armament configurations. Four shortcomings were noted and follow in decreasing order of importance: (1) the high left rolling response to a sudden engine failure at power settings above 75% torque; (2) the undesirable maneuvering stability characteristics above 1.4 g's; (3) insufficient left pedal margin available in right sideward flight above 10 knots in the Hellfire and Hellfire/TOW configurations; and (4) insufficient left pedal margin available for ball-centered forward flight below 30 KCAS in the armament configurations with left lateral cg offset. A CAUTION is recommended for inclusion in the operator's manual dealing with the pilot reaction time and cyclic control inputs during engine failures at high power settings. Additionally, a NOTE is recommended indicating that Stability Control and Augmentation System OFF flight above 80 KCAS in the Stinger/Hellfire/TOW configuration should be avoided for gross weights above 9000 lb.

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION SYSTEMS COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO. 63120-1798

REPLY TO
ATTENTION OF

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SUBJECT: Directorate for Engineering Position on the Final Report of USAAEFA Project No. 84-11, Preliminary Airworthiness Evaluation of the AH-1S (Modernized Cobra) with the HELLFIRE, TOW and Stinger Missiles Installed

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1. The purpose of this letter is to establish the Directorate for Engineering position on the subject report. The objective of the Preliminary Airworthiness Evaluation (PAE) was to obtain limited handling qualities and performance data on the AH-1S(MC) with an in-house developed integrated HELLFIRE, TOW, and Stinger missile system installation. Results of the PAE substantiated that there were no unacceptable handling qualities characteristics which would preclude any operational testing to evaluate the feasibility of the HELLFIRE, TOW and Stinger missile system concept. The PAE also confirmed that there were no handling qualities constraints that would prevent the actual firings of missiles from the AH-1S(MC) under AVSCOM/AEFA Project No. 84-24, "Firing Evaluation of the AH-1S(MC) with the HELLFIRE, TOW and Stinger Missile Configurations". Additionally, an evaluation of a modified Kaiser Electronics Head-Up Display (HUD), which was developed for the Marine Corps AH-1T, was conducted under AVSCOM/AEFA Project No. 84-24-1, "Evaluation of the AH-1S(MC) Helicopter TOW/HELLFIRE/Stinger Head-Up Display". The HUD provided an expanded capability over the existing AH-1S(MC) HUD and allows for a better integration of the HELLFIRE, TOW and Stinger missile systems for weapons firing. The three evaluations resulted in a logical progression of flight testing in a cost effective manner. If at any time the results of an evaluation were unacceptable, the program could have been stopped with minimum cost impact prior to any operational test.

2. This Directorate agrees with the report conclusions and recommendations. Additional comments are provided relative to the report paragraphs as indicated below:

a. Paragraph 26.a. and 26.b. The high left rolling response to a sudden engine failure and the undesirable maneuvering stability characteristics above 1.4 g's are shortcomings that were previously reported. The various weapons configurations tested did not result in improving or degrading the handling qualities; consequently, no action will be taken to correct the shortcomings.

b. Paragraph 26.c. The insufficient left pedal margin in right sideward flight appears to be the result of the gross weight and the HF or HF/TOW configurations. Since the configurations tested are non-standard and the available pedal margin is not a deficiency, no corrective action will be taken.

c. Paragraph 26.d. The insufficient left pedal margin available for ball centered forward flight below 30 KCAS appears to be a result of the left lateral c.g. offset in the SF, HF/TOW and HF configurations. It is important to note that the left lateral c.g. offset is as much as 2.6 inches, which is outside the AH-1S (MC) lateral c.g. limits of 2.0 inches. For the purpose of this evaluation, testing was authorized at the 2.6 inch lateral c.g. offset in the HF configuration. Release of an envelope for operational testing would restrict use of the HF configuration with a lateral c.g. offset exceeding 2.0 inches. Since the configurations tested are non-standard and the available pedal margin is not a deficiency, no corrective action will be taken.

d. Paragraphs 27.a. thru 27.d. The handling qualities of the AH-1S(MC) configured with the HELLFIRE, TOW and Stinger missile configurations failed to meet several MIL-H-8501A specification requirements. The MIL-H-8501A was only used as a guide however for test purposes, and there were no contractual requirements since the evaluation was an in-house program. Consequently, corrections relative only to specification non-compliance are not warranted. Additionally, none of the specification non-compliances resulted in a deficiency and are related only to the shortcomings as identified in the report.

e. Paragraph 29. The CAUTION recommended for inclusion as a change to paragraph 9-14 of the AH-1S(MC) Operator's Manual was reviewed and considered appropriate. Based on the results of this evaluation and the other test results documented in the referenced AH-1S, AH-1S(MC), AH-1S/ECAS and AH-1G test reports the CAUTION recommended to be incorporated improves the current writeup in the AH-1S(MC) Operator's Manual. This CAUTION will be incorporated in the next Operator's Manual revision.

f. Paragraph 30. The incorporation of the NOTE relative to SCAS OFF flight above 80 KIAS is not considered necessary. The report indicates that the SCAS OFF characteristics of the AH-1S(MC) configurations tested are similar to those of the AH-1S(MC). The Operator's Manual already adequately covers SCAS OFF flight in paragraph 5-12. AIRSPEED LIMITS.

3. The results of the PAE substantiate that the handling qualities of the AH-1S(MC) are acceptable with the HELLFIRE, TOW and Stinger missile system. The results of the two other evaluations substantiated an acceptable level of integration of the missile system and HUD. The AH-1S(MC) with the in-house

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developed missile system is considered suitable for an operational test to determine the feasibility of the concept. The current configuration, although suitable for user evaluation of feasibility, is not deemed suitable for production; some modifications for improved fire control interfaces, reliability and maintainability are expected to occur in a follow-on full scale qualification program.

4. AVSCOM - Providing Leaders the Decisive Edge.

FOR THE COMMANDER:

Daniel M. McEneany
DANIEL M. McENEANY
Acting Director of Engineering

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# INTRODUCTION

## BACKGROUND

1. The AH-1S Modernized Cobra (MC) Helicopter was developed to provide the Army with an anti-armor capability. The addition of Hellfire missiles to the existing weapon systems could provide the AH-1S with a dual-missile payload which would enhance the aircraft's anti-armor role by providing greater standoff distances. Limited air-to-air capability would be provided by the addition of Stinger missiles. The asymmetric loadings generated by the various armament configurations required feasibility testing before any missile firing tests could be conducted. The US Army Aviation Systems Command (AVSCOM) tasked the US Army Aviation Engineering Flight Activity (USAAEFA) to conduct a Preliminary Airworthiness Evaluation (PAE) of the AH-1S (MC) helicopter with Hellfire, TOW, and Stinger missiles installed to document flying qualities and level flight performance prior to operational testing (ref 1, app A).

## TEST OBJECTIVE

2. The objective of this test was to conduct a PAE of the AH-1S (MC) helicopter with the Hellfire, TOW, and Stinger systems installed to obtain limited flight performance and flying qualities data.

## DESCRIPTION

3. The test helicopter, an AH-1S (MC) (US Army S/N 69-16423), is a two-place, tandem seat, single engine attack helicopter with two-bladed main and anti-torque rotors, wing stores, and skid landing gear (photo 1). It is manufactured by Bell Helicopter Textron, Inc. and powered by an Avco Lycoming T53-L-703 turboshaft engine with an uninstalled thermal rating of 1800 shaft horsepower (SHP) limited to 1290 SHP by the main rotor transmission. The normal maximum gross weight of the AH-1S (MC) is 10,000 pounds. However, for test purposes the maximum gross weight was increased to 10,500 pounds. The helicopter is equipped with a crashworthy fuel system containing a total fuel capacity of 262 gallons of which 260 are useable. The aircraft contains four wing pylon positions. The two outboard pylons are articulated and may be used to mount the TOW, Hellfire and Stinger missile systems as well as rocket and gun pods. The fixed inboard pylons can also mount the Stinger system in addition to rocket or gun pods. The TOW system tested consisted of two launchers, each capable of firing two missiles. It was installed on the right outboard pylon and weighed 336 pounds when loaded (four dummy

Photo 1. AH-1S(MC) (Cobra) with Stinger, Hellfire, and TOW Installed

missiles). The Hellfire system consisted of one launcher capable of firing four missiles. It was installed on the left outboard pylon and weighed 573 pounds when loaded (four dummy missiles). The Stinger system weighed 172 pounds and consisted of two dummy missiles mounted on each of two launchers with one launcher installed on each inboard stores location. A more detailed description of the AH-1S (MC) may be found in appendix B and in the operator's manual (ref 2, app A). The TOW system is described in references 2 and 3. The Hellfire system is described in the AH-64A operator's manual (ref 4). The Stinger missile system is described in reference 5.

## TEST SCOPE

4. This evaluation included limited performance, handling qualities and structural dynamics testing. The major portion of flight testing was conducted at Edwards Air Force Base, California (field elevation 2302 ft), with testing also conducted at Bakersfield, California (field elevation 488 ft). A total of 46 flights were conducted between 17 May and 27 July 1984 consisting of 56.5 flight hours of which 39 hours were productive. USAAEFA installed, calibrated and maintained all test instrumentation. A detailed listing of the test instrumentation is contained in appendix C. The helicopter was evaluated against the requirements of military specification MIL-H-8501A (ref 6, app A). Flight test data were obtained at gross weights up to 10,400 lb; at a mid-longitudinal center of gravity (cg); at a lateral cg range from one inch right to approximately three inches left; and from 2190 to 11,340 feet density altitude. Handling qualities and structural dynamics tests were conducted at a main rotor speed of 324 revolutions per minute (rpm). However, for performance testing, the rotor speed was varied to maintain a constant referred rotor speed of 316 rpm. Flight restrictions and operating limitations observed during the PAE are contained in the operator's manual (ref 2) and the airworthiness release (ref 7). Testing was conducted in accordance with the test plan (ref 8) in the configurations listed in table 1 and at the conditions shown in tables 2 and 3.

## TEST METHODOLOGY

5. Established flight test techniques and data analysis procedures were used (refs 9 and 10) and are described in appendix D. A Handling Qualities Rating Scale (HQRS) (fig. 1, app D) and a Vibration Rating Scale (VRS) (fig. 2, app D) were used to augment

Table 1. Test Configurations[1]

| Symbol | Configuration[2,3] |
|---|---|
| CL | Clean, without wing stores or launchers |
| LA | Hellfire launcher mounted on left side, TOW launcher mounted on right side |
| TOW | 4 TOW missiles mounted on right outboard station, empty Hellfire launcher mounted on left outboard station |
| HF | 4-Hellfire missiles mounted on left outboard station, 4 TOW missile tubes (empty) mounted on right outboard station |
| HF/TOW | 4-Hellfire missiles mounted on left outboard station, 4 TOW missiles mounted on right outboard station |
| SF | HF/TOW configuration with a full Stinger launcher mounted on each inboard station (4 Stinger missiles total) |

NOTES:

[1]Hellfire, Stinger, and TOW missiles were ballasted dummy rounds.

[2]See appendix B for front view photograph of each configuration

[3]Hellfire missiles were mounted on the left outboard station to produce the largest lateral center of gravity offsets. No testing was conducted with Hellfire missiles mounted on right outboard station.

Table 2. Level Flight Performance Test Conditions[1]

| Configuration | Gross Weight Range (lb) | Density Altitude Range (ft) | Thrust Coefficient Range ($C_T$x$10^4$) | Average Lateral Center of Gravity (in) |
|---|---|---|---|---|
| CL | 8820-8790 | 4100-11,340 | 50.11-69.00 | 0.1 RT |
| LA | 8720-9240 | 3080-10,180 | 49.88-68.90 | 0.4 LT |
| TOW | 9000-9420 | 2190-11,010 | 50.33-68.81 | 0.9 RT |
| HF | 8940-9730 | 3230-8880 | 50.34-68.85 | 2.6 LT |
| HF/TOW | 9150-9520 | 2340-9630 | 50.39-67.96 | 1.6 LT |
| SF | 9370-9520 | 2610-9860 | 52.82-68.94 | 1.6 LT |

NOTE:

[1]Tests conducted in ball-centered flight; at a mid longitudinal center of gravity and a varying lateral center of gravity; and at a referred rotor speed of 316 rpm.

Table 3. Handling Qualities Test Conditions[1]

| Test | Average Gross Weight (lb) | Average Density Altitude (ft) | Calibrated Airspeed Range (kt) | Average Lateral Center of Gravity (in.) | Configuration |
|---|---|---|---|---|---|
| Control Positions[2] in Trimmed Forward Flight | 8790 | 4130 | 29 - 134 | 0.1 RT | CL |
| | 8830 | 4160 | 30 - 129 | 0.4 LT | LA |
| | 8990 | 2340 | 29 - 120 | 0.9 RT | TOW |
| | 8940 | 3070 | 29 - 127 | 2.7 LT | HF |
| | 9140 | 2350 | 29 - 127 | 1.6 LT | HF/TOW |
| | 9290 | 2600 | 29 - 124 | 1.6 LT | SF |
| Static Longitudinal Stability | 9740 | 7640 | 42 - 124 | 2.6 LT | HF |
| | 9860 | 6030 | 42 - 124 | 1.5 LT | HF/TOW |
| | 10080 | 7900 | 43 - 125 | 1.5 LT | SF |
| Static Lateral-Directional Stability | 9520 | 7860 | 65 - 106 | 2.7 LT | HF |
| | 9790 | 7760 | 65 - 106 | 1.6 LT | HF/TOW |
| | 9910 | 7630 | 65 - 106 | 1.6 LT | SF |
| Maneuvering Stability | 8940 | 6380 | 107 | 2.7 LT | HF |
| | 9740 | 8100 | 107 | 1.6 LT | HF/TOW |
| Dynamic Stability[3] | 9460 | 7660 | 60 - 111 | 2.7 LT | HF |
| | 9480 | 7680 | 59 - 109 | 1.6 LT | HF/TOW |
| | 9950 | 8100 | 60 - 107 | 1.6 LT | SF |
| Takeoff Characteristics | 9580 | 3700 | 0 - 35 | 2.6 LT | HF |
| | 9500 | 3510 | 0 - 35 | 1.6 LT | HF/TOW |
| | 9620 | 3730 | 0 - 35 | 1.6 LT | SF |
| Low-Speed Flight[3] | 9500 | 4340 | 0 - 35 | 2.7 LT | HF |
| | 9570 | 4520 | 0 - 35 | 1.6 LT | HF/TOW |
| Mission Maneuvers | 9380 | 4000 | 0 - 100 | 2.6 LT | HF |
| | 9040 | 4030 | 0 - 100 | 1.6 LT | HF/TOW |
| | 9420 | 3780 | 0 - 100 | 1.6 LT | SF |
| Simulated Engine Failures | 9610 | 7330 | 62 - 120 | 2.6 LT | HF |
| | 9970 | 8120 | 65 - 125 | 1.7 LT | HF/TOW |
| SCAS Disengagements | 9670 | 6690 | 0 - 142 | 2.7 LT | HF |
| | 9610 | 6930 | 0 - 130 | 1.6 LT | HF/TOW |
| | 9450 | 8460 | 105 | 1.6 LT | SF |
| Lateral SCAS Hardovers | 9290 | 6860 | 105 - 111 | 2.7 LT | HF |
| | 9080 | 6900 | 105 - 109 | 1.6 LT | HF/TOW |
| Structural Dynamics[4] | 9200 | 7230 | 28 - 121 | 0.4 LT | LA |
| | 9230 | 5800 | 30 - 111 | 0.9 RT | TOW |
| | 9530 | 5850 | 27 - 121 | 2.6 LT | HF |
| | 9570 | 9470 | 30 - 112 | 1.6 LT | HF/TOW |
| | 10200 | 4450 | 27 - 119 | 1.5 LT | SF |

NOTES:
[1]Longitudinal center of gravity (cg): mid, main rotor speed: 319 to 324.
[2]Main rotor speed: 313 to 319.
[3]SCAS ON and SCAS OFF.
[4]Main rotor speed: 308 to 318.

pilot comments relative to aircraft handling qualities and vibrations. Flight parameters were recorded utilizing cockpit instruments and an inflight magnetic tape recorder. Parameters which were considered critical were monitored in real time using telemetry.

# RESULTS AND DISCUSSION

## GENERAL

6. Limited performance and handling qualities data were obtained for the AH-1S (MC) helicopter in the configurations and conditions shown in tables 1 through 3. The aircraft was flown ball-centered for all level flight performance and handling qualities tests. For level flight performance, the rotor speed was varied to maintain a constant referred rotor speed of 316 rpm ($W/\delta$, $N_R/\sqrt{\theta}$ method). A baseline level flight performance evaluation was conducted in the clean configuration. The resulting changes in the equivalent flat plate area were found to vary with airspeed. The increase in flat plate area for the SF configuration reduced maximum level flight speed at normal rated power by approximately 8 knots true airspeed (KTAS). With the exception of the two armament related shortcomings listed below, the handling qualities and the reactions to system failures of the AH-1S (MC) were not significantly changed by the installation of the Hellfire, TOW, and Stinger missiles. Four shortcomings were noted: (1) the high left rolling response to a sudden engine failure at power settings above 75% torque; (2) the undesirable maneuvering stability characteristics above 1.4 g's; (3) insufficient left pedal margin available in right sideward flight above 10 knots in the HF and HF/TOW configurations; and (4) insufficient left pedal margin available for ball-centered flight below 30 knots calibrated airspeed (KCAS) in the left lateral cg offset configurations (SF, HF/TOW, and HF).

## LEVEL FLIGHT PERFORMANCE

7. Level flight performance tests were conducted at the conditions listed in table 2 to determine the change in equivalent flat plate area for each of the five tested configurations. Data were obtained for the clean configuration to provide a baseline, and are presented in nondimensional and dimensional form in figures 1 through 7, appendix E. Data were similarly obtained for the LA, TOW, HF, HF/TOW, and SF configurations, and are presented in non-dimensional and dimensional form in figures 8 through 37. Sideslip angle and the change in equivalent flat plate area varied with airspeed for each configuration as shown in figures 38 and 39. The change in equivalent flat plate area at representative airspeeds for each configuration is listed in table 4. Both sideslip angle and lateral cg contribute to the nonlinear nature of the change in equivalent flat plate area with airspeed. Table 5 shows the effects of the SF configuration compared to the CL configuration on airspeed at representative power settings. At 4000 ft pressure altitude, 35°C, 10,000 lb gross weight, and normal rated power airspeed was reduced by approximately 8 KTAS.

Table 4. Flat Plate Area Drag

| Configuration[1] | Increase in Equivalent Flat Plate Area from Clean Configuration ($ft^2$) 70 KTAS[2] | 100 KTAS | 130 KTAS |
|---|---|---|---|
| LA | 3.2 | 4.6 | 4.2 |
| TOW | 3.4 | 4.8 | 4.8 |
| HF | 11.0 | 7.3 | 6.6 |
| HF/TOW | 9.3 | 6.9 | 6.6 |
| SF | 11.0 | 8.6 | 7.8 |

NOTES:

[1]See Table 1.
[2]KTAS: Knots True Airspeed.

Table 5. Effects of Configuration on Airspeed[1]

| Shaft Horsepower (SHP) Required | KTAS[2] CL[3] | SF[3] |
|---|---|---|
| 700 | 97 | 84 |
| 850 | 116 | 107 |
| 1000 | 127 | 119 |

NOTES:

[1]Level flight, ball-centered, 4000 ft pressure altitude, 35°C, main rotor speed 324 rpm, 10,000 lb gross weight.
[2]Knots True Airspeed.
[3]See table 1

## HANDLING QUALITIES

### General

8. Stability and control and system failure tests were conducted qualitatively and quantitatively to evaluate the handling quali-

ties of the AH-1S (MC) for each weapons configuration. With the exception of the two armament related shortcomings listed below, the handling qualities and the reactions to system failures of the AH-1S (MC) were essentially unchanged by the installation of the Hellfire, TOW, and Stinger missiles. Four shortcomings were noted: (1) the high left rolling response to a sudden engine failure at power settings above 75% torque; (2) the undesirable maneuvering stability characteristics above 1.4 g's; (3) insufficient left pedal margin available in right sideward flight above 10 knots in the HF and HF/TOW configurations; and (4) insufficient left pedal margin available for ball-centered forward flight below 30 KCAS in the left lateral cg offset configurations (SF, HF/TOW, and HF).

## Control Positions in Trimmed Forward Flight

9. Control positions in ball-centered forward flight were obtained in conjunction with level flight performance at the conditions listed in table 3. The test results are presented in figures 40 through 45, appendix E. The average lateral cg during these tests varied from 1.0 inch right for the TOW configuration to 2.7 inches left for the HF configuration. Because of the left offset, additional right lateral cyclic was required to maintain ball-centered forward flight in the SF, HF/TOW, and HF configuraations compared to the CL, LA, and TOW configurations. Insufficient left pedal was available for trimmed flight below 30 KCAS in the SF, HF/TOW, and HF configurations. Pedal margins at 30 KCAS in these configurations were less than 10% (0.6 inches). The insufficient left pedal margin available in ball-centered forward flight below 30 KCAS in the left lateral cg offset configurations (SF, HF/TOW, and HF) is a shortcoming. The directional pedal control positions in ball-centered level flight for the SF, HF/TOW, and HF configurations failed to meet the intent of paragraph 3.3.4 of MIL-H-8501A.

## Static Longitudinal Stability

10. The static longitudinal stability characteristics of the AH-1S (MC) was evaluated in the HF, HF/TOW, and SF configurations at the conditions shown in table 3. Tests were conducted by trimming the aircraft in ball-centered flight at the desired airspeed and then stabilizing at approximately 5 knot increments up to 20 knots faster and slower than the trim airspeed with the collective position held fixed. Data were recorded at each stabilized airspeed and are presented in figures 46 through 51, appendix E. At both the low and high trim airspeeds, the static longitudinal stability, as indicated by the variation of longitudinal cyclic control position with airspeed, was stable (increasing forward longitudinal control with increasing airspeed).

For all configurations tested, the gradient of longitudinal cyclic position versus airspeed was shallow at low speed (approximately 0.018 inch/knot). The gradient became more shallow at 107 KCAS, ranging from 0.013 inch/knot (HF configuration) to 0.016 inch/knot in the HF/TOW and SF configurations. The static longitudinal stability characteristics were compared with a previous evaluation (ref 11, app A) and were essentially unchanged. The static longitudinal stability characteristics of the AH-1S (MC) for each weapons configuration tested are satisfactory.

Static Lateral-Directional Stability

11. The static lateral-directional stability of the test aircraft for the HF, HF/TOW, and SF configurations was evaluated at the conditions shown in table 3. Tests were conducted by first trimming the aircraft in ball-centered level flight and then stabilizing at incrementally increasing left and right sideslip angles. Data were recorded at zero turn rate with airspeed, collective control, and sideslip angle held constant. Test data are presented in figures 52 through 57, appendix E. Static directional stability was positive (increasing left directional control with increasing right sideslip) throughout the sideslip envelope for both trim airspeeds and all tested configurations and is satisfactory. Dihedral effect was also positive (increasing right lateral cyclic control with increasing right sideslip) for both trim airspeeds and all tested configurations and is satisfactory. Sideforce cues (as indicated by bank angle variation with sideslip) at the lower trim airspeed were weak and pilot workload to maintain aircraft trim was increased. At the higher trim airspeeds the sideforce cues were stronger and the pilot workload to maintain trimmed flight was reduced. A comparison of the static lateral-directional characteristics with those previously reported for the AH-1S (ECAS) (ref 11, app A) indicated that the static lateral-directional characteristics were essentially unchanged.

Maneuvering Stability

12. The maneuvering stability of the AH-1S (MC) for the HF and HF/TOW configurations was evaluated in steady-state left and right turns at the conditions shown in table 3. The steady-state turns were conducted by trimming the aircraft in ball-centered flight at 107 KCAS and then stabilizing at incrementally increasing roll attitudes while maintaining collective control position and airspeed constant. Test data are presented in figures 58 through 61, appendix E. The variation of longitudinal cyclic position with normal load factor (g) was positive (increased aft cyclic displacement with increasing g) and was essentially

unchanged from those exhibited in a previous evaluation (ref 11, app A). At g levels greater than 1.4 g, small longitudinal cyclic control inputs resulted in large airspeed changes so that the pilot tended to "chase" the desired airspeed. Considerable pilot compensation was required to maintain airspeed within ±5 knots (HQRS 5). The undesirable maneuvering stability characteristics above 1.4 g's significantly increased pilot workload and remain an uncorrected shortcoming for the attack helicopter mission (ref 11, app A).

Dynamic Stability

13. The longitudinal and lateral-directional dynamic stability of the AH-1S (MC) for the HF, HF/TOW, and SF configurations were evaluated at the conditions shown in table 3. The short-term response was evaluated with SCAS ON and SCAS OFF utilizing control pulses in both directions in all axes. The pulse was made by trimming the aircraft in level flight (66 KCAS to 111 KCAS), rapidly displacing the desired flight control up to 1 inch from trim for a duration of 0.5 seconds, and then returning the control to the original position. The flight controls were then held fixed until corrective recovery became necessary or the aircraft motions were damped. Time histories of representative responses are presented in figures 62 through 72, appendix E. With SCAS ON the short-term response to lateral-directional inputs was heavily damped and was similar to that observed in a previous AH-1S evaluation (ref 11, app A). The directional control pulses resulted in high initial roll and yaw rates which quickly damped out. Lateral-directional damping decreased as airspeed increased. The short-term dynamic stability of the AH-1S (MC) with SCAS ON for the weapons configurations tested was satisfactory and essentially unchanged from previous evaluations.

14. During the SCAS OFF evaluation of the short-term response, significant roll-yaw coupling (lateral-directional oscillation) was observed (figs. 64, 67, 68, and 69, app E). This lateral-directional response is characteristic of the AH-1S (MC) helicopter and has been reported in previous evaluations (ref 11, app A). At 66 KCAS in the Hellfire configuration the response from a one inch pedal pulse was oscillatory and slightly convergent resulting in ±10 degree roll and yaw attitude changes with roll rates up to 10 deg/sec and yaw rates up to 5 deg/sec (fig. 64). At 86 KCAS in the Hellfire/TOW configuration the response to a left lateral pulse was a neutral oscillation with roll and yaw rates up to 10 deg/sec (fig. 69). The SCAS OFF short-term lateral-directional oscillation remains unchanged from previous evaluations and for a degraded mode is satisfactory within the airspeed range tested.

15. The long-term response was evaluated SCAS ON and OFF in the HF, HF/TOW, and SF configurations at the conditions shown in table 3. The test was accomplished by trimming the aircraft in level flight, slowing the aircraft with aft cyclic control to an airspeed 10 knots below trim airspeed, then returning the control to the trim position and noting the aircraft response. The pilot applied lateral and directional control inputs to obtain a single axis response. Representative time histories at 64 KCAS (SCAS ON) and 86 KCAS (SCAS OFF) are shown in figures 73 and 74, appendix E. The long-term response was oscillatory and slightly convergent with a period of approximately 33 seconds with SCAS ON at 64 KCAS and 28 seconds with SCAS OFF at 86 KCAS. The long-term response of the AH-1S (MC) appears unchanged from previous evaluations and is satisfactory.

## Low-Speed Flight Characteristics

16. The handling qualities of the AH-1S (MC) during low speed flight were evaluated in the HF and HF/TOW configurations at the conditions listed in table 3. The aircraft was flown SCAS ON and OFF in right sideward and rearward flight in ground effect at a skid height of approximately 10 feet. A calibrated fifth wheel mounted on a pace vehicle was used as a speed reference. Winds during the test were less than 5 knots. The data are presented in figures 75 through 82, appendix E.

17. Longitudinal and lateral control position did not fall below 10 percent control margin during the tests. Directional control margin was less than 10 percent in right sideward flight above approximately 10 knots for both configurations tested. Between 0 and 15 knots, maintaining heading and bank angle within ±3 degrees was difficult (HQRS 4) with SCAS ON, but workload decreased above 20 knots (HQRS 3). With SCAS OFF sideward and rearward flight at 15 knots and below was difficult (HQRS 6) because of bank angle oscillations in sideward flight and nose tuck in rearward flight. Workload decreased in both directions above 20 knots (HQRS 5). The insufficient left pedal margin available in right sideward flight above 10 knots in the HF and HF/TOW configurations is a shortcoming. Directional control remaining during right sideward flight above 10 knots in the HF and HF/TOW configurations failed to meet the intent of paragraph 3.3.4 of MIL-H-8501A.

## Mission Maneuvers

18. A qualitative evaluation of mission maneuvering characteristics was accomplished throughout this test. Specific test conditions are presented in table 3. Aircraft agility and

maneuverability were assessed during accelerations and decelerations from a hover and in forward flight, pop-ups (vertical flight path displacement in low-speed flight), bob-ups (vertical flight path displacements from a hover), nap-of-the-earth flying, and contour flying. The mission maneuvering characteristics of the AH-1S (MC) were essentially unchanged by the addition of the Hellfire, TOW, and Stinger missile systems. However, the gross weight at which many mission maneuvers could be performed was restricted by the limited out-of-ground effect (OGE) hover performance and directional control power (paras 9 and 17) at high gross weight (above 9400 lb). The increased weight of the Hellfire (573 lb for four missiles and launchers) and the Stinger (172 lb for four missiles and launchers) will limit mission maneuver capablility during OGE and low speed flight unless the fuel and/or payload is significantly reduced.

## Aircraft Systems Failures

### Simulated Engine Failures:

19. The response of the test helicopter to a simulated sudden engine failure was evaluated in the HF and HF/TOW configurations at the conditions listed in table 3 with SCAS ON. Engine failure was simulated by rapidly rolling the throttle to the flight idle position. The controls were held fixed following the simulated power loss until necessary to avoid unusual aircraft attitudes or a transient rotor speed of 260 rpm or less was reached. Representative time histories are presented in figures 83 through 86, appendix E.

20. The primary aircraft response following simulated sudden engine failure was a left roll with a less severe left yaw. The severity of aircraft response was significant as noted in previous tests of the AH-1 (refs 11, 12, and 13, app A). It increased directly with increased entry engine torque prior to failure. Airspeed also had a significant but lesser influence on aircraft response. Test results indicated flight control delay times were approximately 0.5 seconds for entries at power settings above 75% torque. The high roll and yaw rates following the loss of power provided immediate cues to the pilot and the low rotor rpm warning system provided an audio cue approximately one second following the power loss. Above 75% torque, the combination of roll rate and rotor speed decay required extensive pilot effort (HQRS 6) to control roll rate and rotor speed. Aft cyclic control input immediately following simulated engine failure at high power settings and high airspeed significantly helped to control rotor decay. Due to the high roll acceleration generated by the simulated engine failures, large lateral cyclic inputs

were required (approximately 1.75 inches to the right). The high left rolling response to a sudden engine failure at power settings above 75% torque is a shortcoming. The two second collective delay requirement of paragraph 3.5.5 of MIL-H-8501A (ref 6, app A) could not be obtained at torque settings above 75%. The AH-1S (MC) failed to meet the requirements of paragraph 3.'.5.1 of MIL-H-80501A in that roll attitude change one second after engine failure exceeded 10 degrees by 6 degrees for trim torque settings above 75%. The aircraft response following simulated sudden engine failure as determined by previous and current testing is similar for all AH-1S (MC) configurations. The "CAUTION" of paragraph 9-14 of the AH-1S (MC) operator's manual (ref 2) should be changed to read:

CAUTION

> Engine failures at high power settings (75% or greater at airspeeds up to 135 KIAS; 62.5% at airspeeds greater than 135 knots) require a pilot recognition and reaction time of less than one second to preclude unacceptable high left roll rates and roll attitude changes in excess of 60 degrees to the left. Heavy buffeting of the tail boom and vertical fin and heavy control feedback during recovery are associated with engine failure at high power conditions or high speed. Pilots should avoid rapid right cyclic reversals during recovery to minimize the possibility of mast bumping.

Stability and Control Augmentation System Disengagements:

21. Simultaneous three-axes Stability and Control Augmentation System (SCAS) failures were evaluated in the HF, HF/TOW, and SF configurations at the conditions listed in table 3. Representative time histories are presented in figures 87 through 96, appendix E. The tests were accomplished by stabilizing the aircraft at the appropriate trim airspeed, then simultaneously failing all three channels of SCAS utilizing the pilot's SCAS release switch. The flight controls were held fixed for a minimum of 3 seconds following the failures. Recovery consisted of returning the aircraft to straight and level flight and re-engaging the SCAS when the airspeed was less than 100 KIAS. For airspeeds below 100 KCAS in all configurations tested, recoveries

required very little compensation to maintain roll and yaw attitude within 3 degrees (HQRS 3). For airspeeds above 100 KCAS an unstable roll and yaw oscillation developed. However, roll and yaw rates increased slowly and at least a 5 second delay was possible at all airspeeds before pilot inputs were required. The pilot workload for recovery increased slightly (HQRS 5) due to the tendency to over control the lateral cyclic and directional controls during the speed reduction for recovery. After a SCAS disengagement at 105 KCAS in the SF configuration, the pilot maintained controls fixed for 28 seconds. Roll rates increased to 20 degrees/second and yaw rates to 10 degrees/second before recovery was attempted. The pilot workload for recovery was very high (HQRS 8). The SCAS OFF characteristics of the AH-1S (MC) in the configurations tested are similar to the standard AH-1S (MC). The following NOTE should be incorporated in the operator's manual: SCAS OFF flight above 80 KCAS with 4 Hellfire missiles mounted on the left outboard station, 4 TOW missiles mounted on the right outboard station, and 2 Stinger missiles mounted on each inboard station should be avoided for gross weights above 9000 lb.

Stability and Control Augmentation System Hardovers:

22. SCAS hardover failures were evaluated in the roll axis for the HF and HF/TOW configurations at the conditions presented in table 3. Representative time histories are presented in figures 97 through 100, appendix E. The hardover failures were simulated by using a SCAS pulser box which allowed inputs of 25, 50, 75 and 100 percent of full SCAS actuator travel. Recovery was initiated as necessary to prevent the aircraft from exceeding a 60 degree bank angle. For 100 percent authority lateral SCAS hardovers in both the left and right directions, roll rates approached 30 degrees/second. The aircraft was recovered with gradual lateral cyclic inputs of less than two inches. Delay times were less than two seconds. Aircraft reactions for both configurations tested were similar. The lateral axis hardover characteristics of the SCAS system are satisfactory.

## STRUCTURAL DYNAMICS

### Vibration

23. Vibration characteristics were qualitatively evaluated throughout the test program and quantitatively evaluated in level flight at the conditions in table 3. Vibration sensors were installed at the aircraft cg, the pilot seat, and on the Hellfire

rack mounted on the left wing. Data are presented in figures 101 through 117, appendix E. Vibration levels at the pilot seat did not appear to vary as a function of aircraft configuration. In level flight between 30 and 90 KIAS vibration ratings were VRS 3. Above 90 KIAS vibration ratings were VRS 4 and at maximum level flight airspeed ($V_H$) vibration levels were more noticeable (VRS 5). With rotor rpm ($N_R$) below 97% $N_R$, vibration levels were high above 90 KIAS (VRS 7). However, operation in the transient rotor speed range (91 to 97% $N_R$) is not normal for tactical missions and, therefore, the resulting higher vibrations were not considered objectionable. During level flight it was noted that the left wing store appeared to vibrate vertically at a frequency of 2/rev. The amplitude appeared to increase with increasing airspeed (up to approximately $\pm$ one inch). The pilot and gunner experienced no vibration levels which unduly impaired performance or comfort. The vibration levels at the pilot station are satisfactory with main rotor speed in the normal operating range.

### Structural Loads

24. The left wing attaching point loads were measured axially at the upper forward and middle wing lugs (photo 1, app C) prior to and in conjunction with other tests at the conditions specified in table 3. The results for representative static and dynamic maneuvers in the Hellfire/TOW configuration are summarized in table 6.

Table 6. Measured Wing Mounting Loads

| Flight Condition | Axial Force (lb) | | | |
|---|---|---|---|---|
| | Forward Mount | | Center Mount | |
| | Mean (Tension) | Oscillatory | Mean | Oscillatory |
| Level Flight, $V_H$ | 180 | ±300 | 920 | ±1000 |
| Level Flight, 100 kts | 150 | ±300 | 850 | ±600 |
| Level Flight, 70 kts | 180 | ±200 | 900 | ±400 |
| Level Flight, 40 kts | 210 | ±200 | 1050 | ±400 |
| Right 60° Bank, 60 kts | 300 | ±500 | 1620 | ±1200 |
| Aft Longitudinal Pulse, 1", 100 kts | 150 | ±300 | 1020 | ±800 |

NOTE: Hellfire/TOW Configuration, SCAS ON, average gross weight: 9870 lb.

# CONCLUSIONS

GENERAL

25. Based on the Preliminary Airworthiness Evaluation of the AH-1S (MC) helicopter configured with Hellfire, TOW, and Stinger missiles, the following conclusions were reached:

a. With the exception of the two armament related shortcomings, the handling qualities of the AH-1S (MC) were essentially unchanged with the installation of the Hellfire, TOW, and Stinger missiles.

b. Four shortcomings were noted.

c. Four items of specification noncompliance were noted.

SHORTCOMINGS

26. The following shortcomings were identified and are listed in decreasing order of importance:

a. The high left rolling response to a sudden engine failure at power settings above 75% torque (para 20).

b. The undesirable maneuvering stability characteristics above 1.4 g's (para 12).

c. The insufficient left pedal margin available in right sideward flight above 10 knots in the HF and HF/TOW configurations (para 17).

d. The insufficient left pedal margin available for ball-centered forward flight below 30 KCAS in the left lateral cg offset configurations (SF, HF/TOW, and HF) (para 9).

SPECIFICATION NONCOMPLIANCE

27. The handling qualities of the AH-1S (MC) configured with Hellfire, TOW, and Stinger missiles met the requirements of MIL-H-8501A against which they were tested except as listed below.

a. Paragraph 3.3.4. - The directional pedal control margin in ball-centered level flight below 30 knots in the SF, HF/TOW, and HF configurations were less than 10% (0.6 inches) (para 9).

b. Paragraph 3.3.4. - The directional pedal control margin in right sideward flight above 10 knots in the HF and HF/TOW configurations were less than 10% (0.6 inches) (para 17).

c. Paragraph 3.5.5. - Aircraft reactions following a simulated engine failure at torque settings above 75% precluded safe autorotational entry after a 2 second control delay (para 20).

d. Paragraph 3.5.5.1. - The roll attitude change following simulated sudden engine failure exceeded the 10 degree limit by up to 6 degrees (para 20).

# RECOMMENDATIONS

28. The shortcomings listed in paragraph 26 a through d be corrected.

29. The CAUTION of paragraph 9-14 of the AH-1S (MC) operator's manual (ref 2, app A) should be changed to read (para 20):

CAUTION

> Engine failures at high power settings (75% or greater at airspeeds up to 135 KIAS; 62.5% at airspeeds greater than 135 knots) require a pilot recognition and reaction time of less than one second to preclude unacceptable high left roll rates and roll attitude changes in excess of 60 degrees to the left. Heavy buffeting of the tail boom and vertical fin and heavy control feedback during recovery are associated with engine failure at high power conditions or high speed. Pilots should avoid rapid right cyclic reversals during recovery to to minimize the possibility of mast bumping.

30. A following NOTE should be incorporated in the operator's manual:

NOTE

> SCAS OFF flight above 80 KCAS with 4 Hellfire missiles mounted on the left outboard station, 4 TOW missiles mounted on the right outboard station, and 2 Stinger missiles mounted on each inboard station should be avoided for gross weights above 9000 lb (para 21).

# APPENDIX A. REFERENCES


1. Letter, AVSCOM, DRSAV-ED, 16 May 1984, subject: Preliminary Airworthiness Evaluation of the AH-1S (MC) with Hellfire, TOW, and Stinger Missiles Installed, USAAEFA Project No. 84-11.

2. Technical Manual, TM 55-1520-236-10, *Operator's Manual, Army Model AH-1S (MC) Helicopter,* 11 January 1980, with Change 8 dated 16 January 1984.

3. Technical Manual, TM 9-1425-473-20, *Organizational Maintenance Manual for Armament Subsystem Helicopter, TOW Guided Missile M-65 (TOW Airborne System),* Change 9, dated 15 September 1975.

4. Technical Manual, TM 55-1520-238-10, *Operator's Manual, Army Model AH-64A Helicopter,* 28 June 1984.

5. Technical Bulletin, TB 43-0001-49-2, *Stinger Air Defense Systems Equipment Improvement Report and Maintenance Digest,* 1 July 1984.

6. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling Qualities, General Requirements For,* 7 September 1961, amended 3 April 1962.

7. Letter, AVSCOM, DRSAV-E, 15 May 1984 and 26 May 1984, subject: Airworthiness Release for Preliminary Airworthiness Evaluation of the AH-1S (MC) Configured with the Hellfire, TOW, and Stinger.

8. Test Plan, USAAEFA Project No. 84-11, *Preliminary Airworthiness Evaluation of the AH-1S (Modernized Cobra) Configured with the Hellfire, TOW, and Stinger Missiles,* April 1984.

9. Engineering Design Handbook, Army Material Command, AMC Pamphlet 706-204, *Helicopter Performance Testing,* 1 August 1984.

10. Flight Test Manual, Naval Air Test Center, FTM 101, *Helicopter Stability and Control,* 10 June 1968.

11. Final Report, USAAEFA Project No. 78-03, *Preliminary Airworthiness Evaluation of the AH-1S Helicopter Installed with Enhanced Cobra Armament System (AH-1S/ECAS),* February 1979.

12. Final Report, USAAEFA Project No. 70-25, *Engineering Flight Test AH-1G (Huey Cobra) Helicopter Autorotational Entry Characteristics,* April 1971.

13. Letter Report, USAAEFA Project No. 79-04, Preliminary Airworthiness Evaluation of Production AH-1S Helicopter With 90-Degree Gearbox and Skid Cross-Tube Fairings Removed, March 1980.

14. Engine Specification, Lycoming Division. No. T53-L-703, *Turboshaft Engine,* Model No. 104.43, 1 May 1974.

# APPENDIX B. AIRCRAFT DESCRIPTION

## GENERAL

1. The AH-1S (Modernized Cobra (MC)) helicopter is a tandem seat, two place, single engine aerial weapons platform. A three-axis Stability and Control Augmentation System (SCAS) is provided with actuators limited to ±12.5 percent authority. The fuselage (forward section) employs aluminum alloy skin and aluminum, titanium and fiberglass honeycomb panel construction. Honeycomb deck panels and bulkheads attached to main beams produce a box-beam structure. These beams make up the primary structure and provide support for the cockpit, landing gear, wings, engine, pylon assembly, fuel cells, and tailboom. The nose section incorporates a 20 MM cannon mounted on a universal turret and a gyro stablized telescopic sight unit. The tailboom is a tapered semi-monocoque structure and supports the cambered vertical stabilizer, tail skid, elevators, and tail rotor drive system. The AH-1S(MC) incorporates two fixed cantilever wings which have a span of 129 inches (wing tip to wing tip) and a mean chord of 30 inches. The primary function of the wings is to provide support for wing store pylons. Each wing has two pylons. The inboard pylons are fixed and the outboard pylons are articulated (pitch axis only). The outboard pylons are limited by the operator's manual (ref 2, app A) to 483 lb. Additional description of the AH-1S (MC) is contained in the operator's manual and shown in photos 1 through 8.

## POWER PLANT

2. The T53-L-703 turboshaft engine is installed in the AH-1S(MC) helicopter. This engine employs a two-stage, axial-flow free power turbine: a two-stage, axial flow turbine driving a five-stage axial and one-stage centrifugal compressor; variable inlet guide vanes; and an external annular combustor. A 3.2105:1 reduction gear located in the air inlet housing reduces power turbine speed to a nominal output shaft speed of 6604.3 rpm at 100 percent N2. Maximum uninstalled engine shaft horsepower (shp) is 1800 shp on a sea level standard day condition. However, installed in the AH-1S aircraft, the engine is limited by the transmission to 1290 shp for 30 minutes at an indicated airspeed below 100 knots indicated airspeed (KIAS) and to 1135 shp above 100 KIAS.

## STABILITY AND CONTROL AUGMENTATION SYSTEM

3. The SCAS is a limited authority (±12.5% of total pilot control authority), three axis, rate damping system. The system

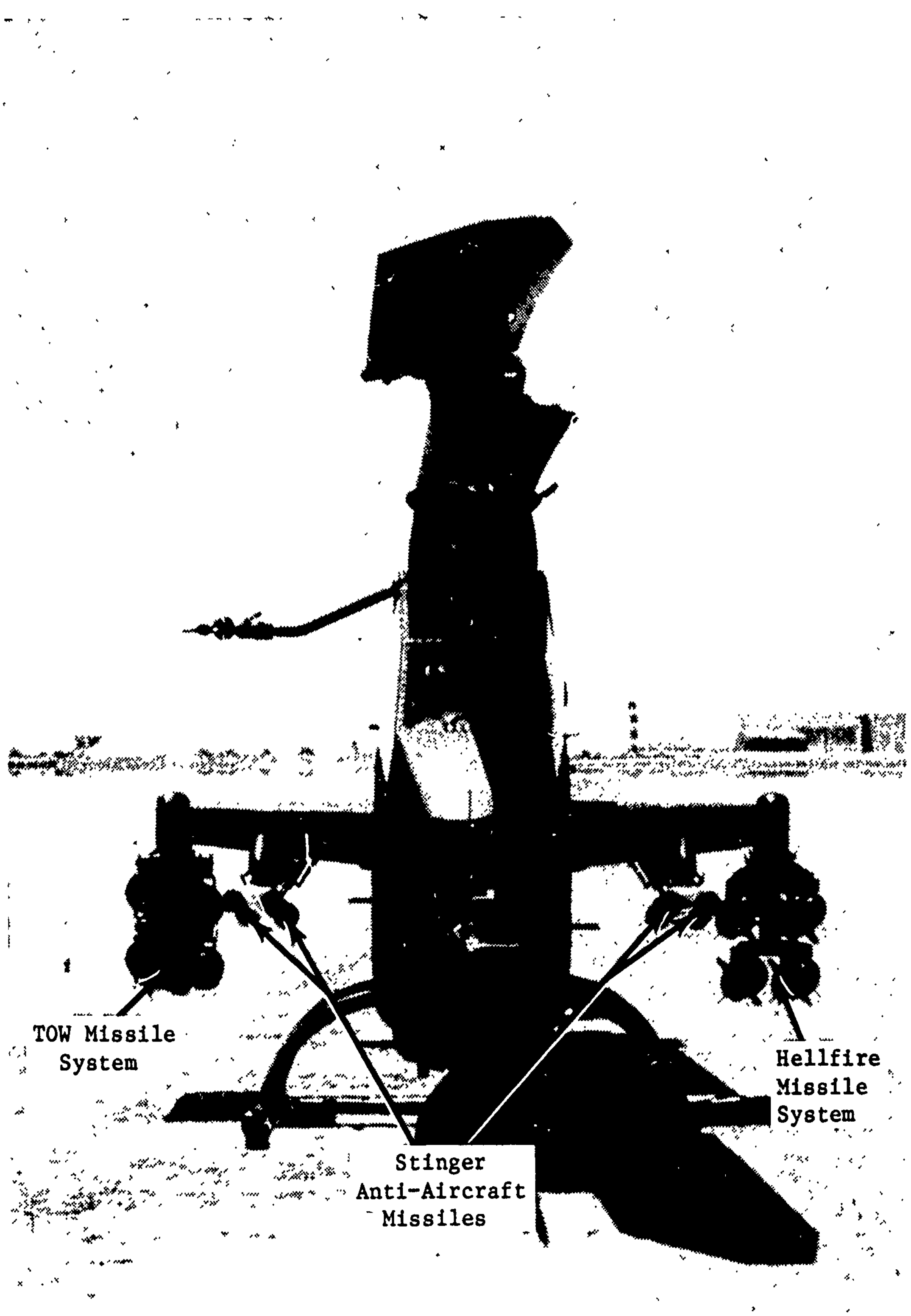



Photo 1. Front View. AH-1S(MC) in the Stinger/Hellfire/TOW (SF) Configuration

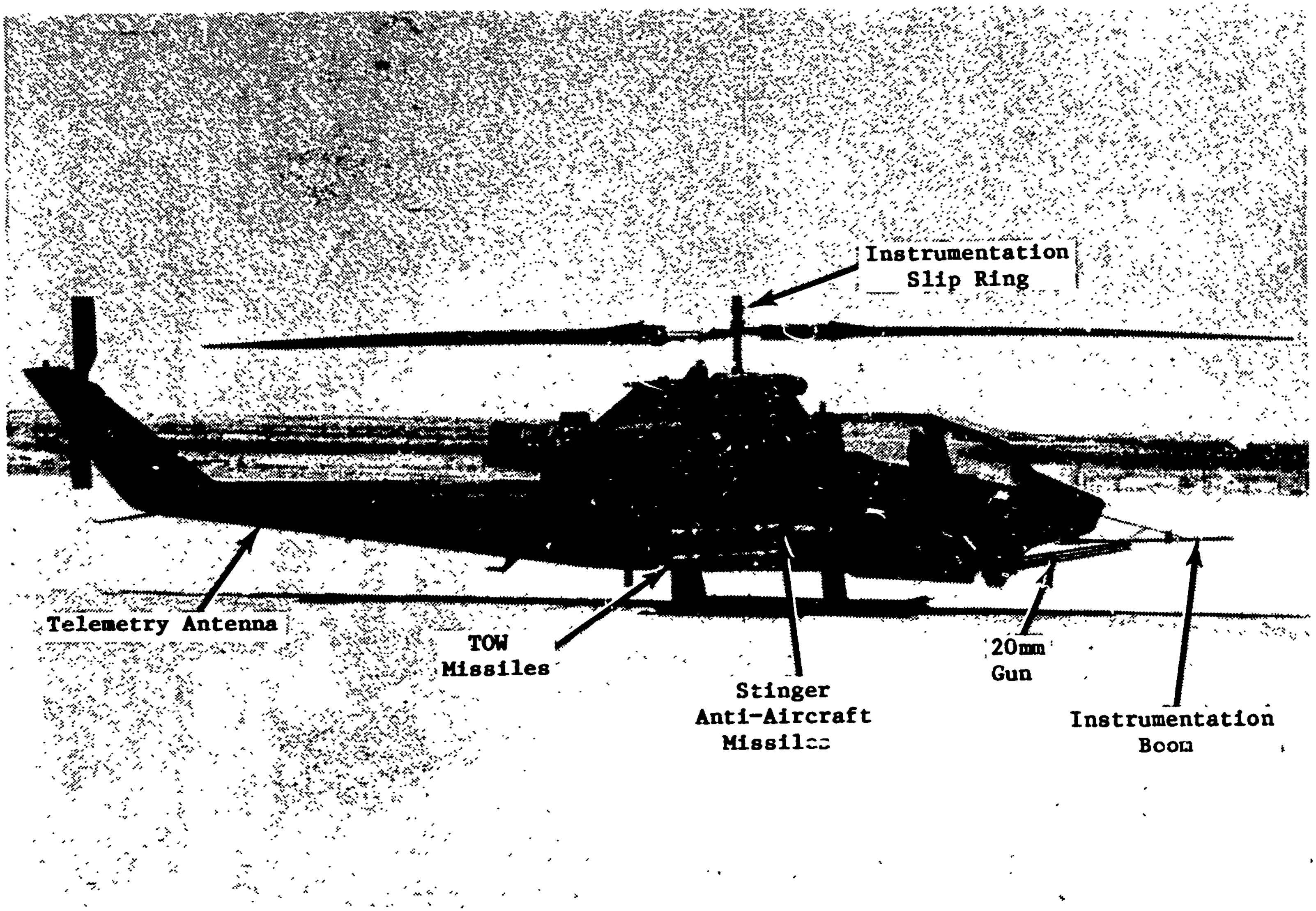



Photo 2. Right View, AH-1S(MC) in the Stinger/Hellfire/TOW (SF) Configuration

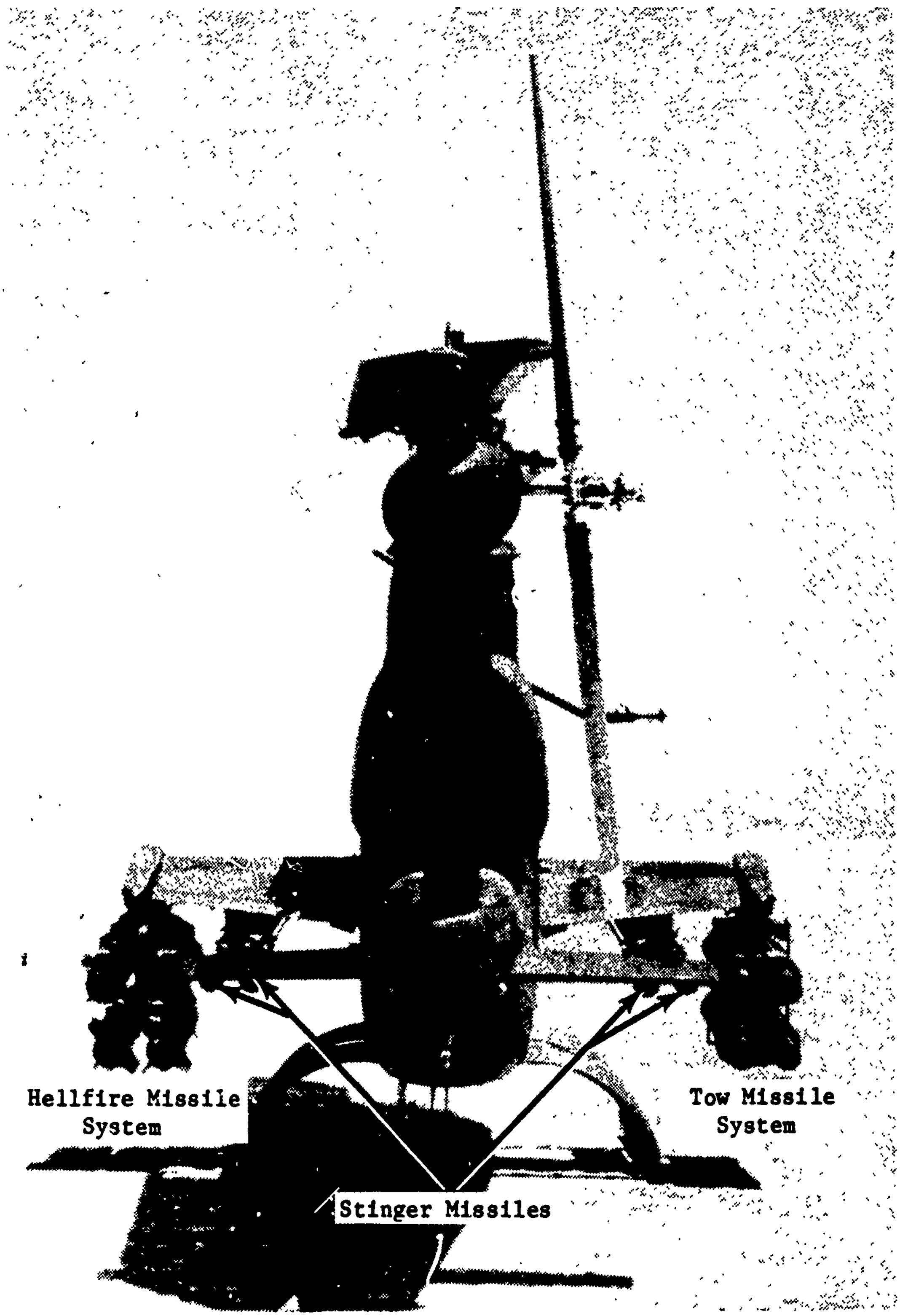



Photo 3. Rear View, AH-1S(MC) in the Stinger/Hellfire/TOW (SF) Configuration

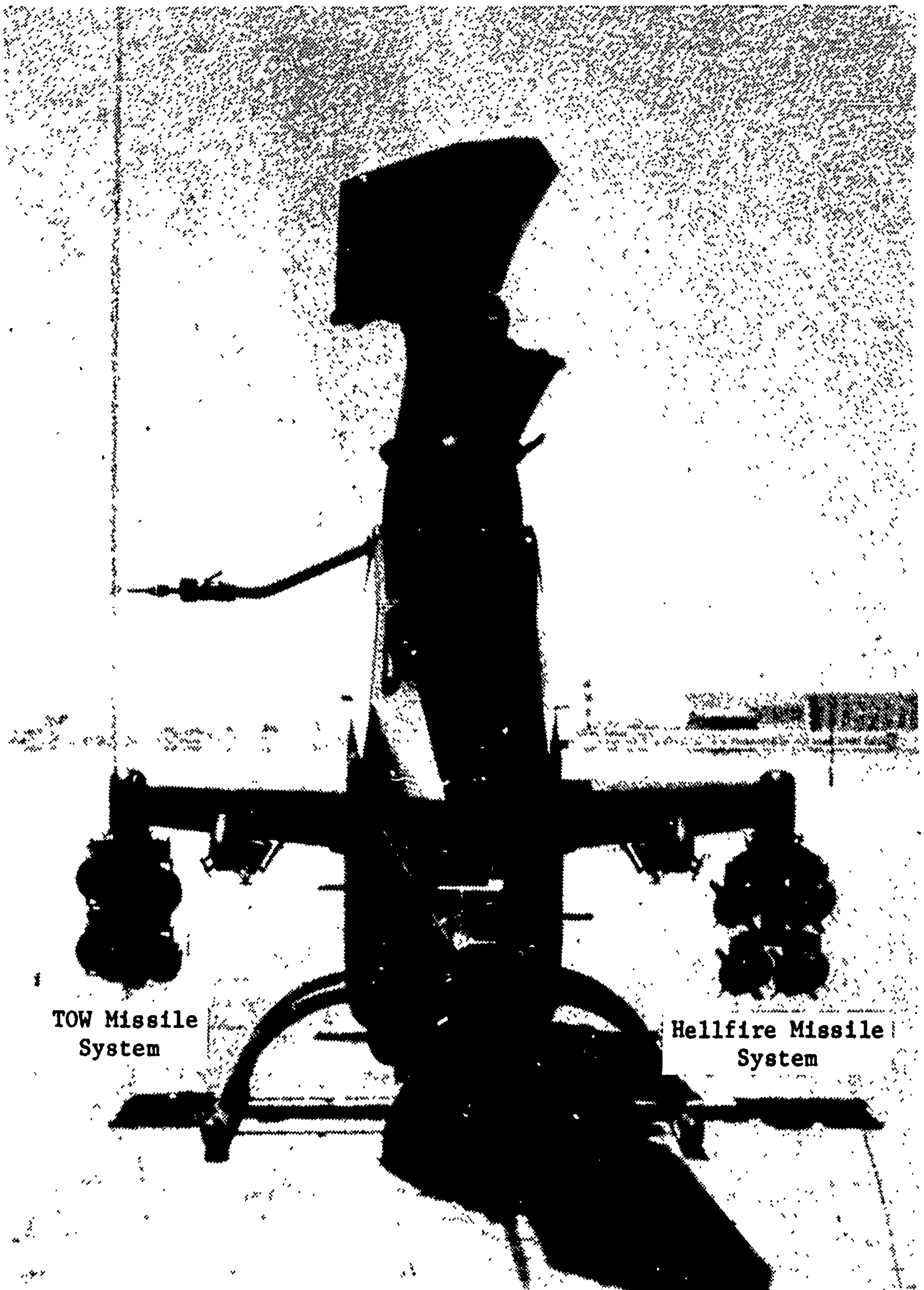



Photo 4. Front View, AH-1S(MC) in Hellfire/TOW (HF/TOW) Configuration

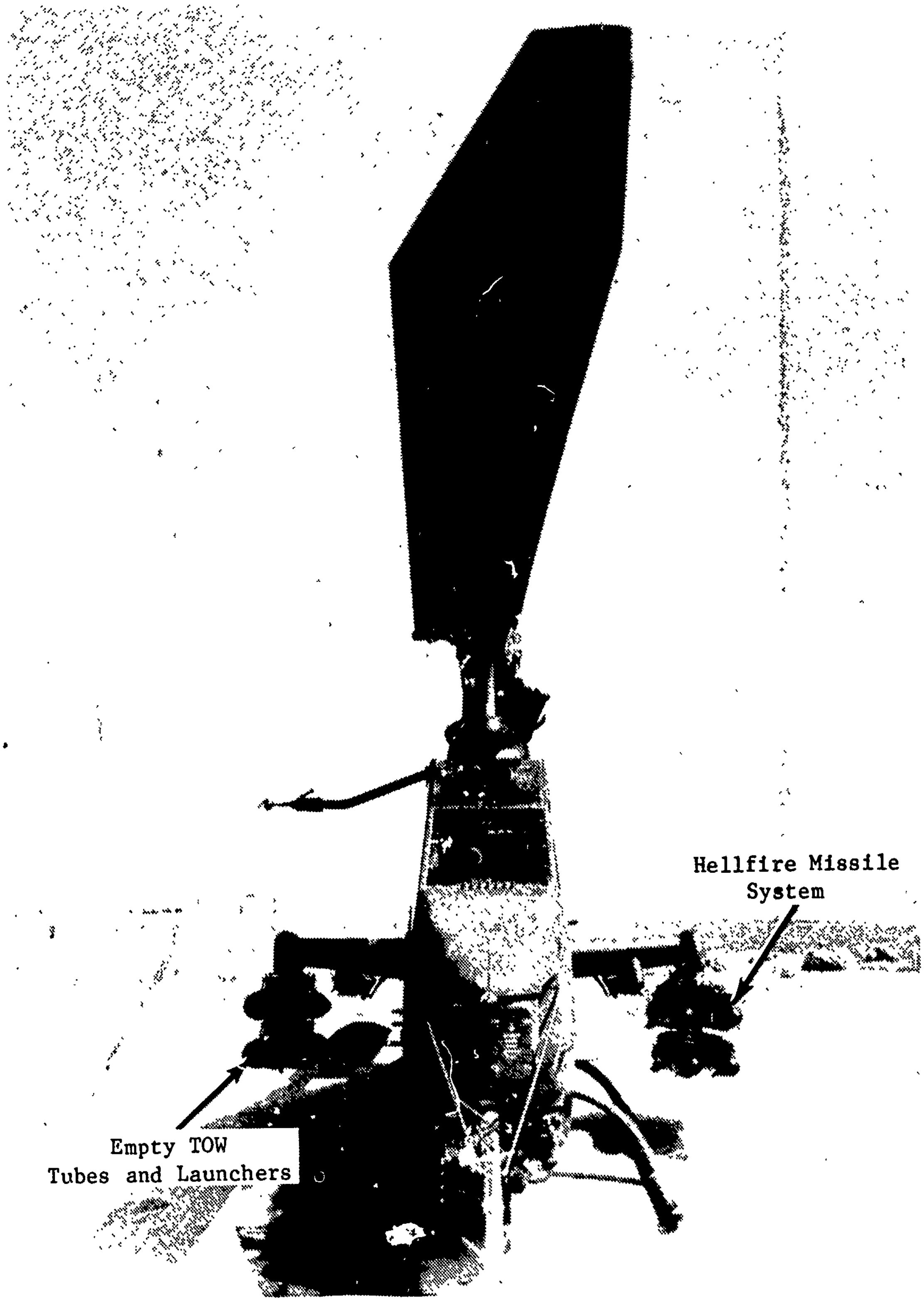



Photo 5. AH-1S(MC) in the Hellfire (HF) Configuration

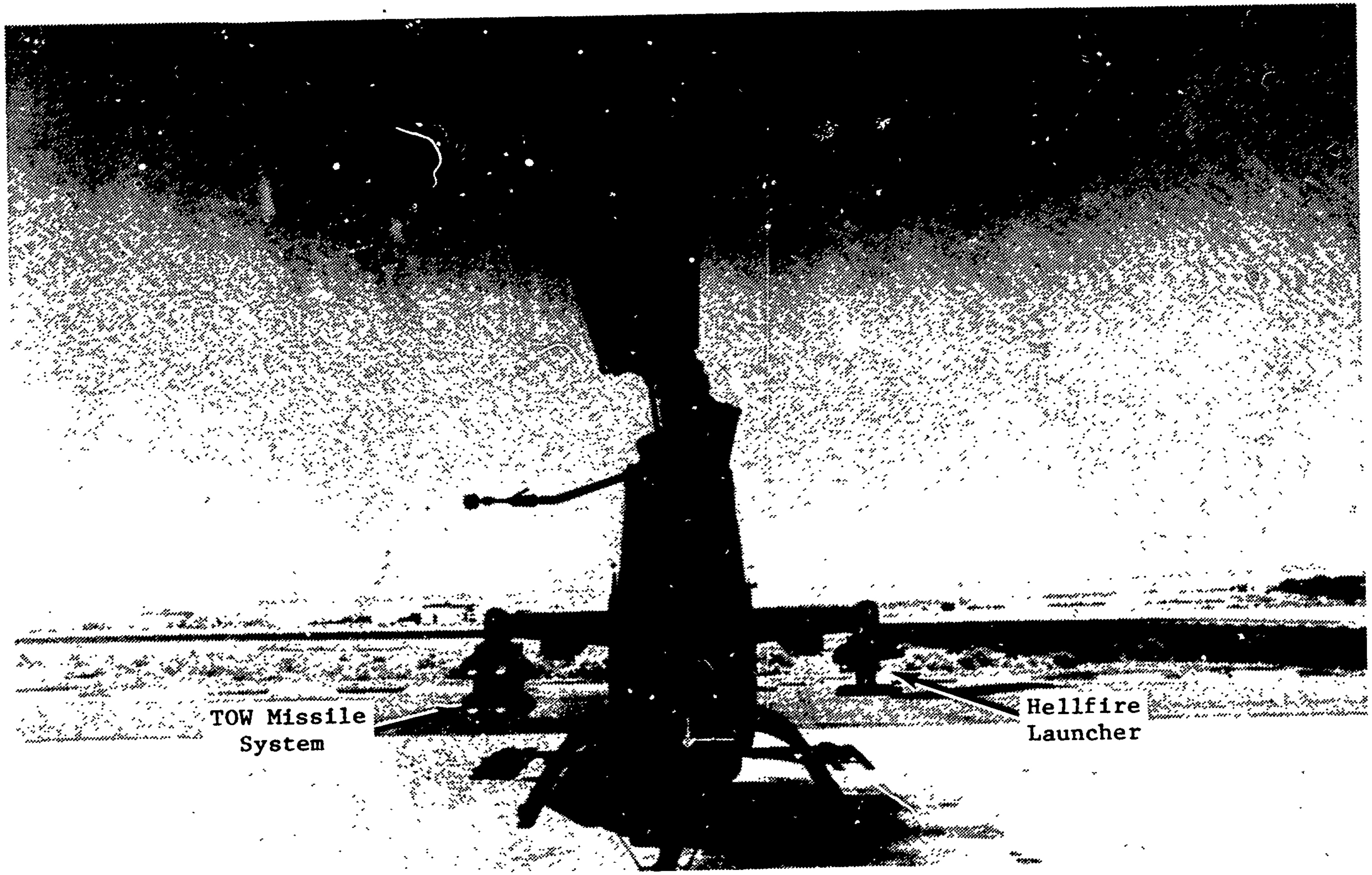



Photo 6. AH-1S(MC) in the TOW Configuration

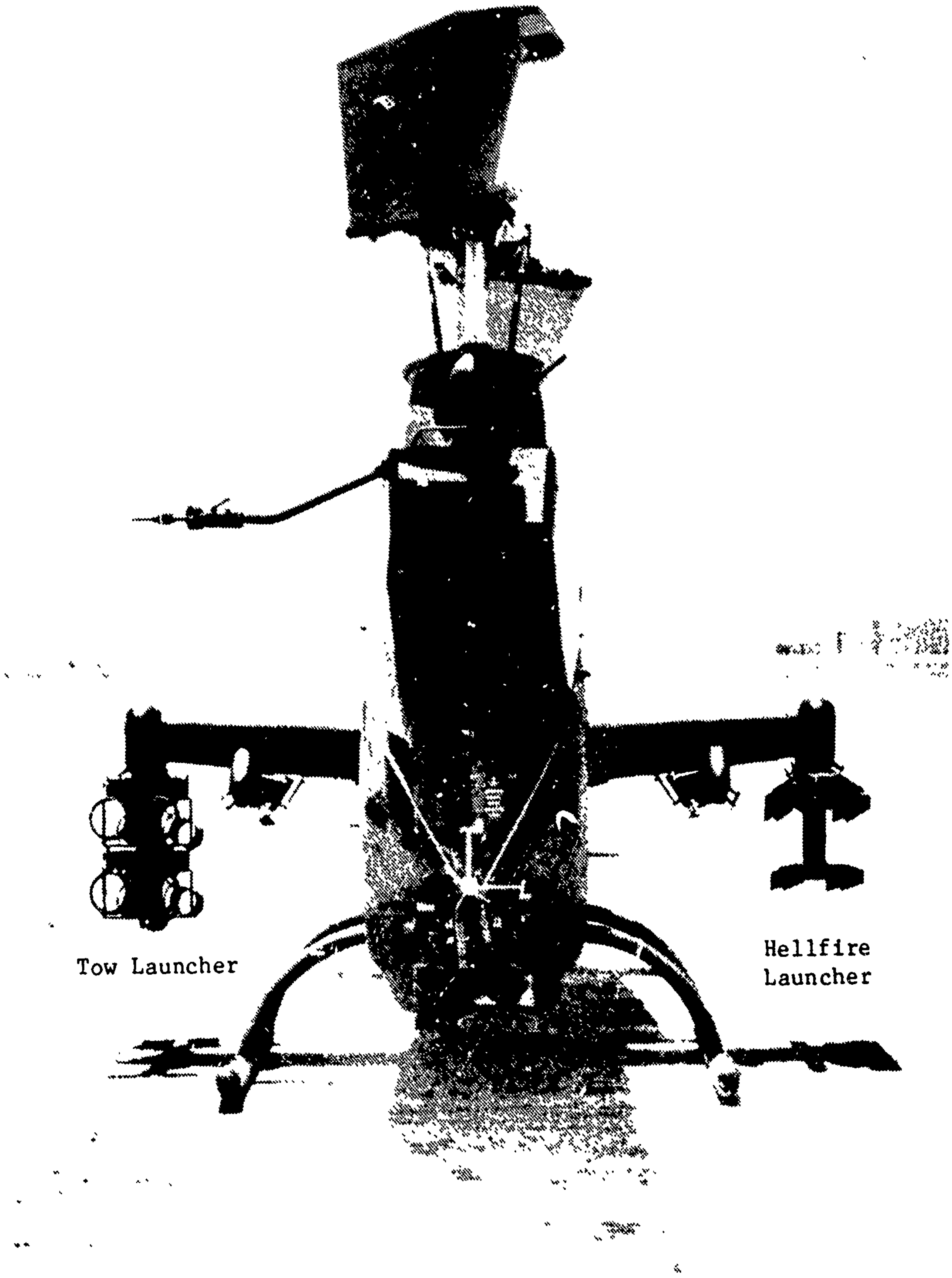



Photo 7. AH-1S(MC) in the Launcher (LA) Configuration

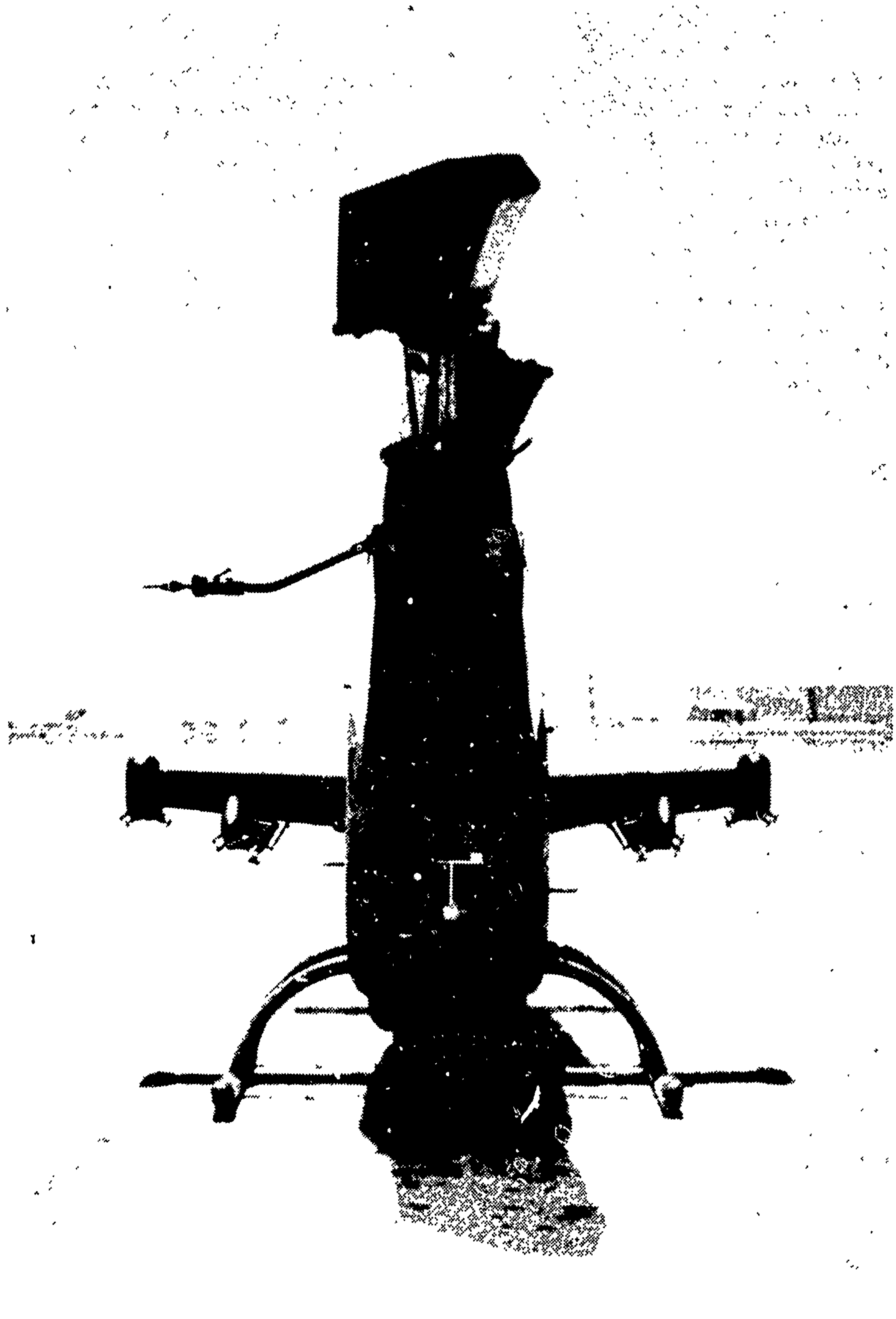


Photo 8. AH-1S(MC) in the Clean (CL) Configuration

is designed to cancel uncommanded helicopter rates by introducing electro-hydraulic inputs into the flight control system to augment pilot inputs (fig. 1). The directional SCAS servo actuator is powered by the number one hydraulic system and the longitudinal and lateral servo actuators are powered by the number two hydraulic system. A block diagram showing the functional relationship between individual SCAS components is presented in figure 2. The SCAS is controlled through the SCAS control panel (fig. 3) located on the pilot left console, and the SCAS release switches on the pilot and gunner cyclic control grips. The panel includes a power switch and three amber NO-GO lights, each associated with one of the SCAS channel (roll, yaw, pitch) engagement switches. The NO-GO lights are illuminated during system warm up and go out when the system is ready for engagement. The SCAS pitch, roll, and yaw engage switches energize the appropriate channels of the SCAS and the electrical solenoid valves that control hydraulic pressure to the SCAS servo actuators. The cyclic grip SCAS release switches disengage all SCAS channels simultaneously and the channels must then be reengaged individually using the switches on the SCAS control panel. The sensor amplifier unit (fig. 4) is located behind the aft cockpit and contains three modules, one for each pitch, roll, and yaw channel. The sensor amplifier unit receives inputs from other components of the SCAS, sums, shapes, and amplifies the signals, then applies the output to the SCAS electro-hydraulic actuators.

4. Each channel of the SCAS consists of three functional loops: control (inner) loop, airframe (outer) loop, and pilot supplementary electrical (input) loop as shown in figure 5. The control loop is designed to provide proportional control in that the electro-hydraulic actuator displaces the main dual hydraulic cylinders a constant magnitude per unit of input to the amplifier. SCAS actuator position information is fed back to the sensor amplifier modules via control transducers. The airframe loop is designed to provide attitude rate stabilization and airframe damping. The rate gyros in the three axis rate sensor monitor and report to the sensor amplifier modules the actual angular rate of movement of the helicopter. The pilot loop provides pilot input to the inner loop through the use of control motion transducers, which are mechanically connected to the controls. These transducers are designed to electrically measure the movement of the controls due to pilot inputs and feed these pilot rate command signals forward to the appropriate sensor amplifier module. The sensor amplifier modules compare these signals with the airframe loop and inner loop inputs, then provide final signals to the electro-hydraulic actuators which extend or retract to adjust the aircraft rate to that commanded by the pilot.

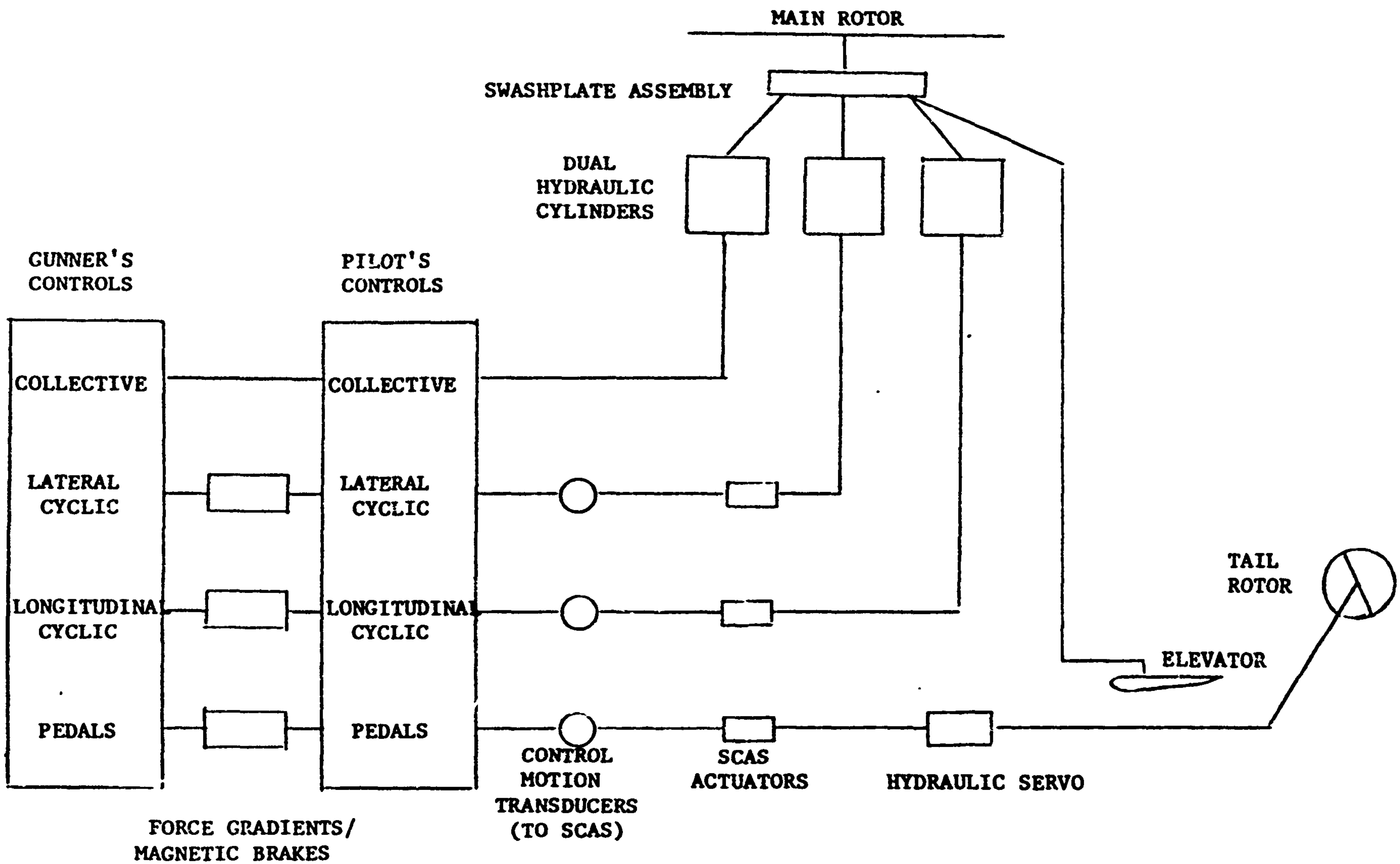



Figure 1. Flight Control System Schematic

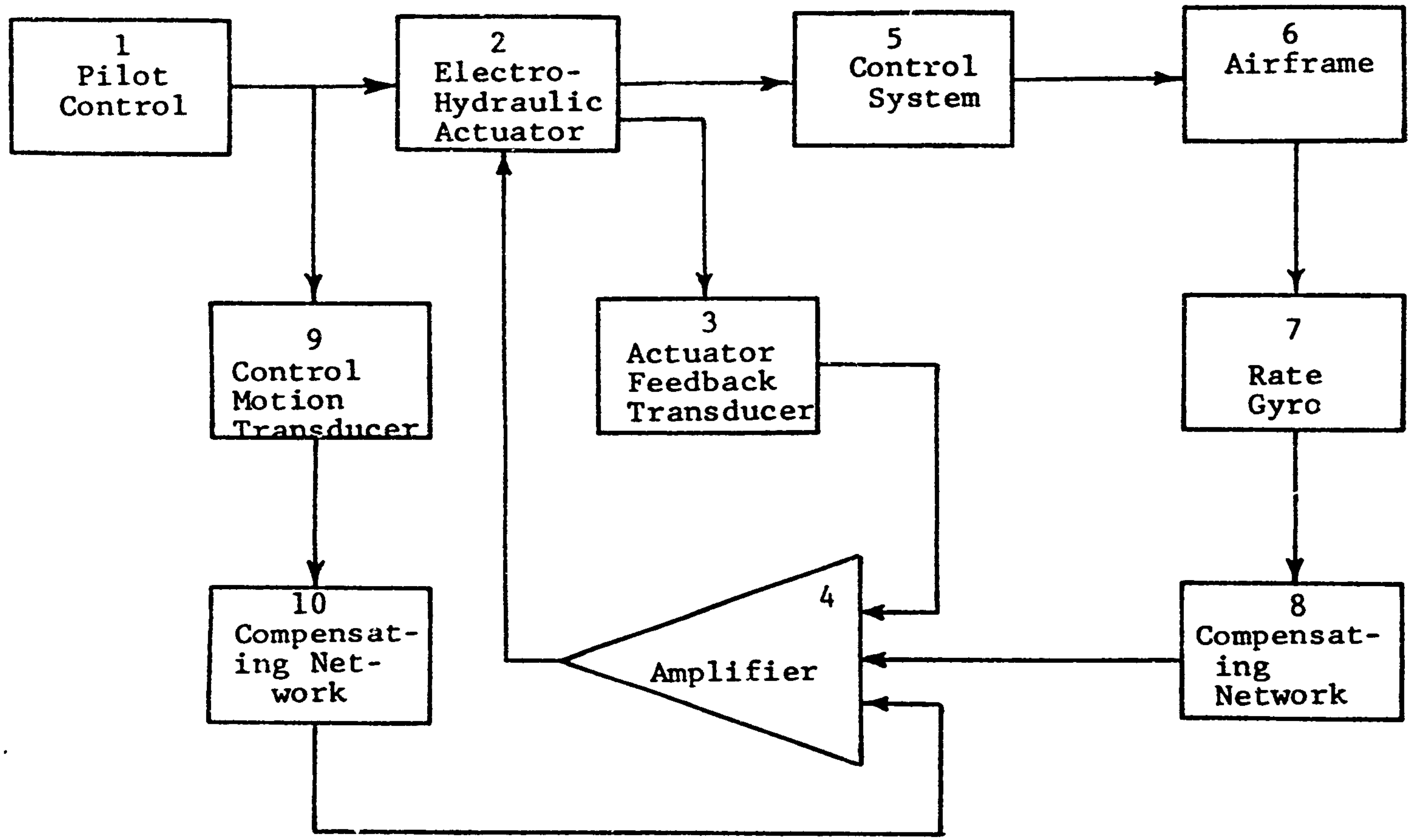



Figure 2. SCAS Functional Block Diagram

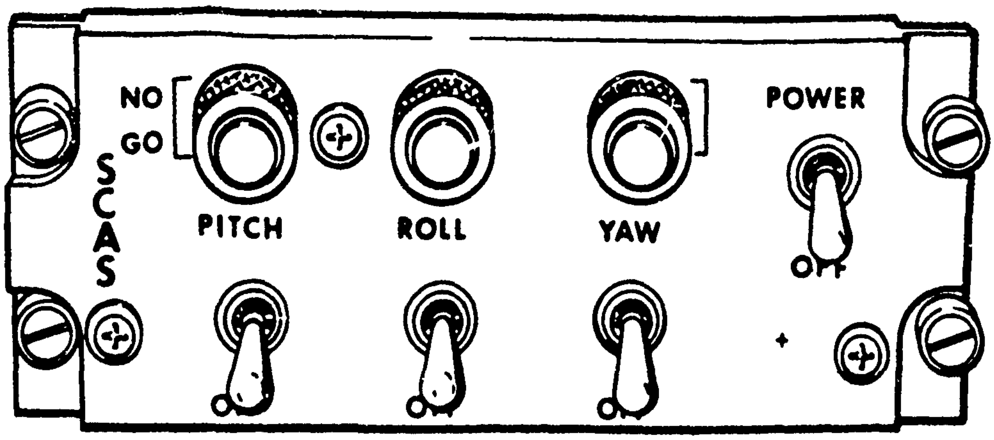



Figure 3. SCAS Control Panel

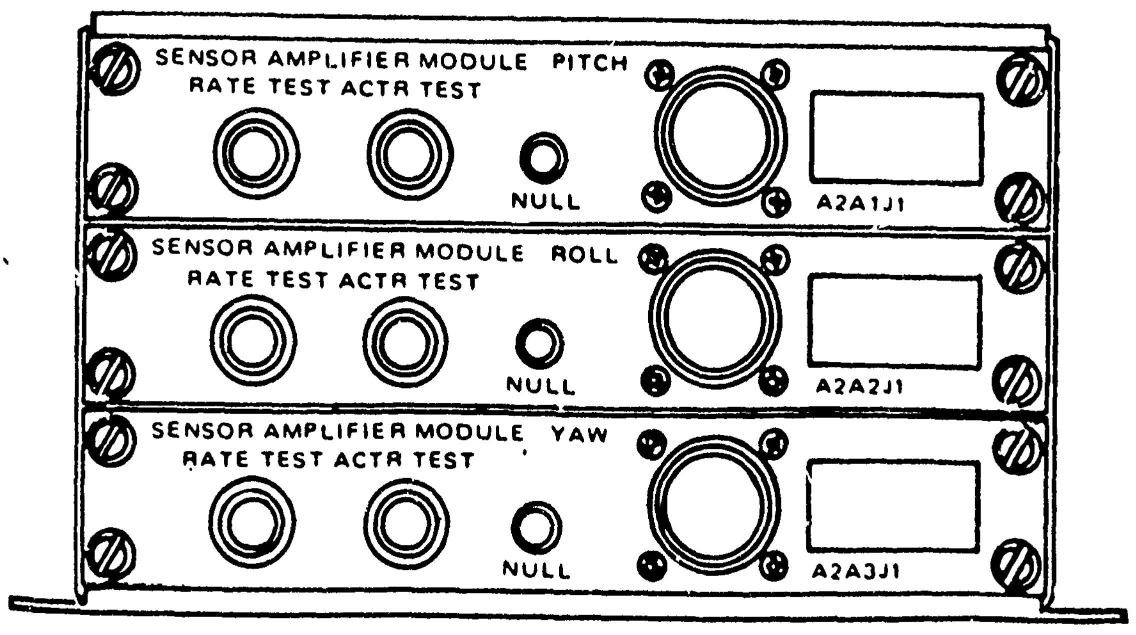



Figure 4. SCAS Sensor Amplifier Unit

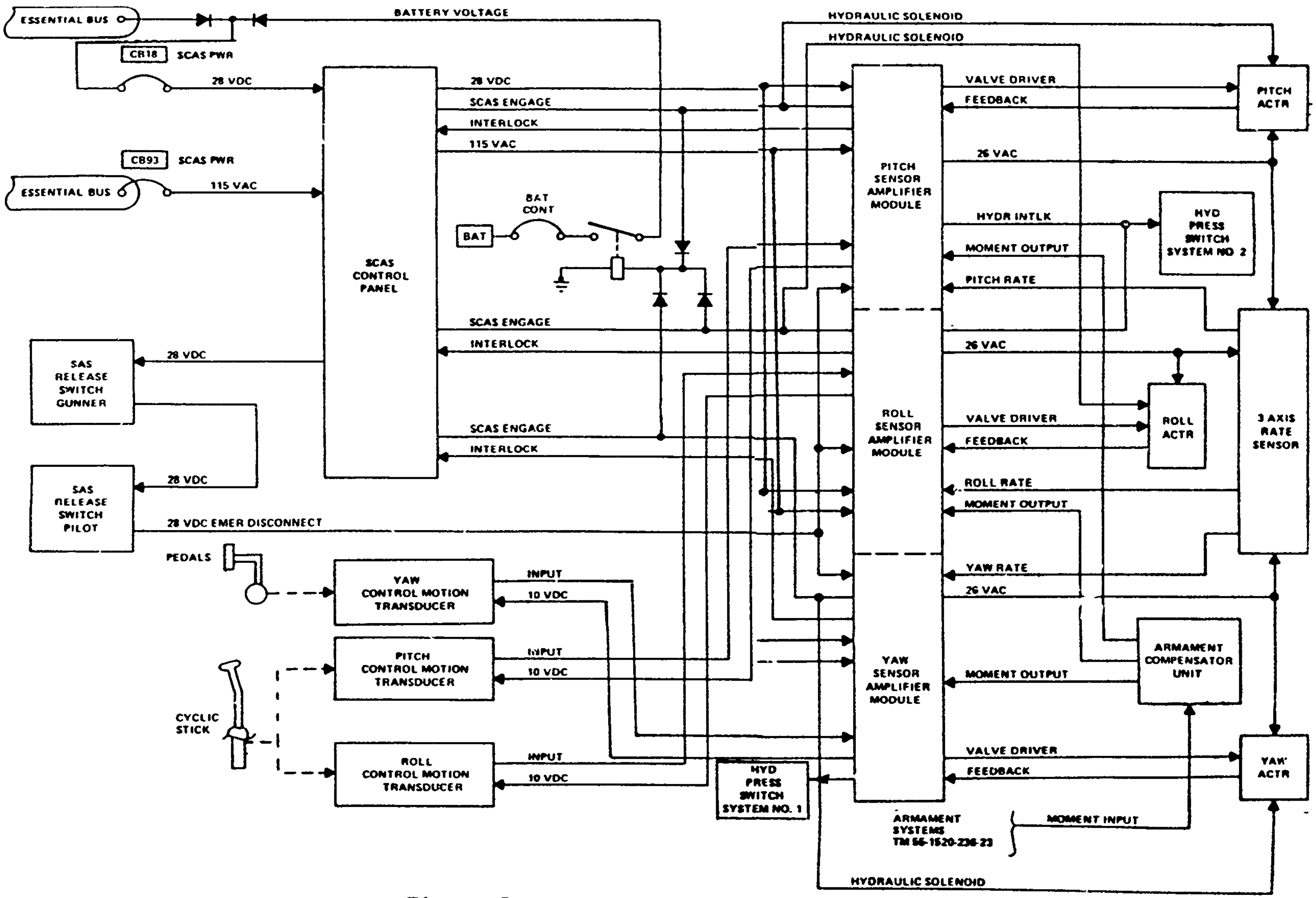



Figure 5. SCAS Block Diagram

## TUBE-LAUNCHED, OPTICALLY-TRACKED, WIRE-COMMAND-LINK (TOW) MISSILE SUBSYSTEM XM65

5. The TOW missile, weighing 54 lb each, is a heavy anti-tank/assault weapon primarily effective in daylight conditions and utilizes optical and infrared means to track a target. Guidance is achieved through a wire attached from the launcher rail to the rear of the missile. The Telescopic Sight Unit, which the copilot/gunner uses to track the target, is gyro-stabilized and isolated from vibration in all three axes. The maximum effective range of the TOW missile is 3750 meters. During this evaluation empty TOW missile tubes filled with ballast and capped with aluminum plates were used to simulate the live missile. A more detailed description of the operation of the subsystem is contained in reference 3, appendix A.

## HELLFIRE MISSILE SYSTEM M244

6. The Hellfire system provides the capability of firing a point target missile weighing 98.5 lb at aircraft speeds from hover to $V_{NE}$, on the ground or airborne, and during day or night conditions. The missile contains a tri-service laser seeker giving the crew the capability to lock-on-before-launch or lock-on-afterlaunch either with an onboard or ground laser target designator. The Hellfire has the capability of up to three programmed launch trajectories and several firing modes. The current range of the system is classified. As installed on this aircraft (photos 9 and 10), training rounds were employed which simulated the weight and drag characteristics of the service round. A more detailed description of the Hellfire missile system is contained in reference 4, appendix A.

## STINGER MISSILE SYSTEM XM44

7. The Stinger missile system is a lightweight (approximately 86 lb with 2 missiles and launcher) anti-aircraft weapon employing autonomous infrared and other classified means of guidance. With a range of at least 2.5 nautical miles it has the capability of successfully defeating both head-on and retreating high speed targets. During this test two inert rounds mounted on each inboard station (in the SF configuration) were used to simulate the actual live missiles (photos 11 through 13). A more detailed description of the operation and maintenance of the Stinger system is contained in reference 5.

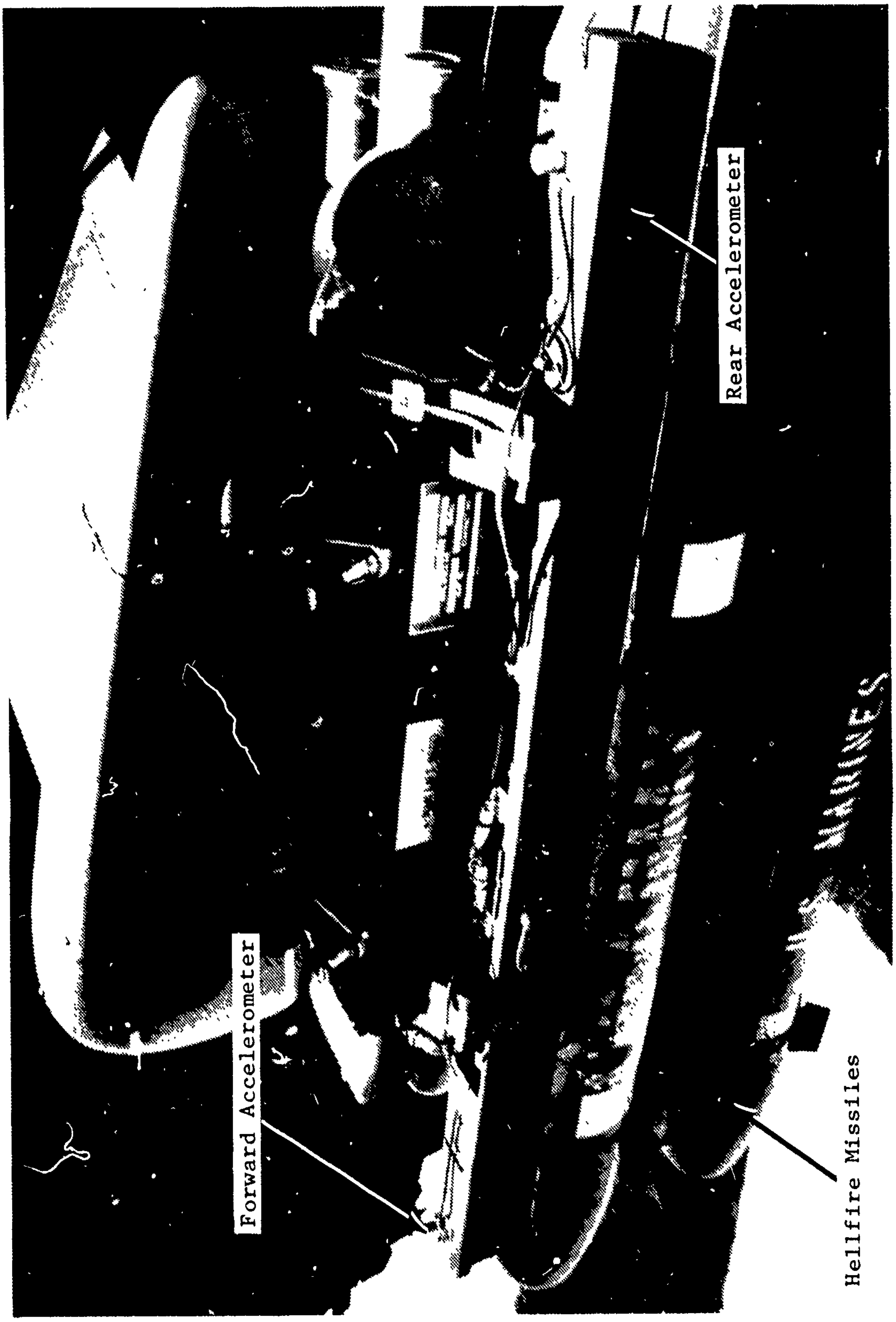



Photo 9. Left Three-Quarter View of Hellfire Missile System Installed on Left Outboard Wing Station

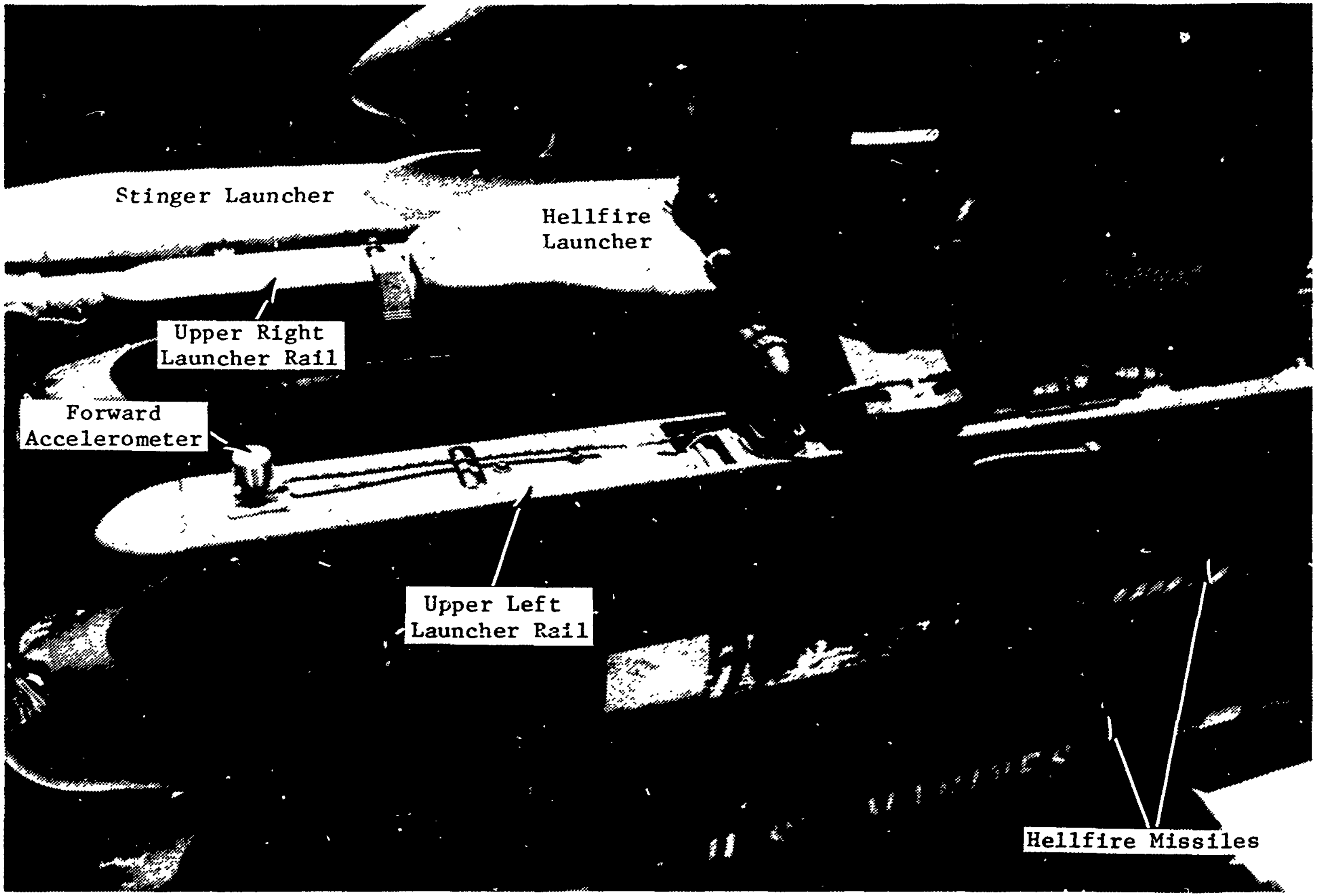



Photo 10. Left Quarter View of Hellfire Missile System Installed on Left Outboard Wing Station

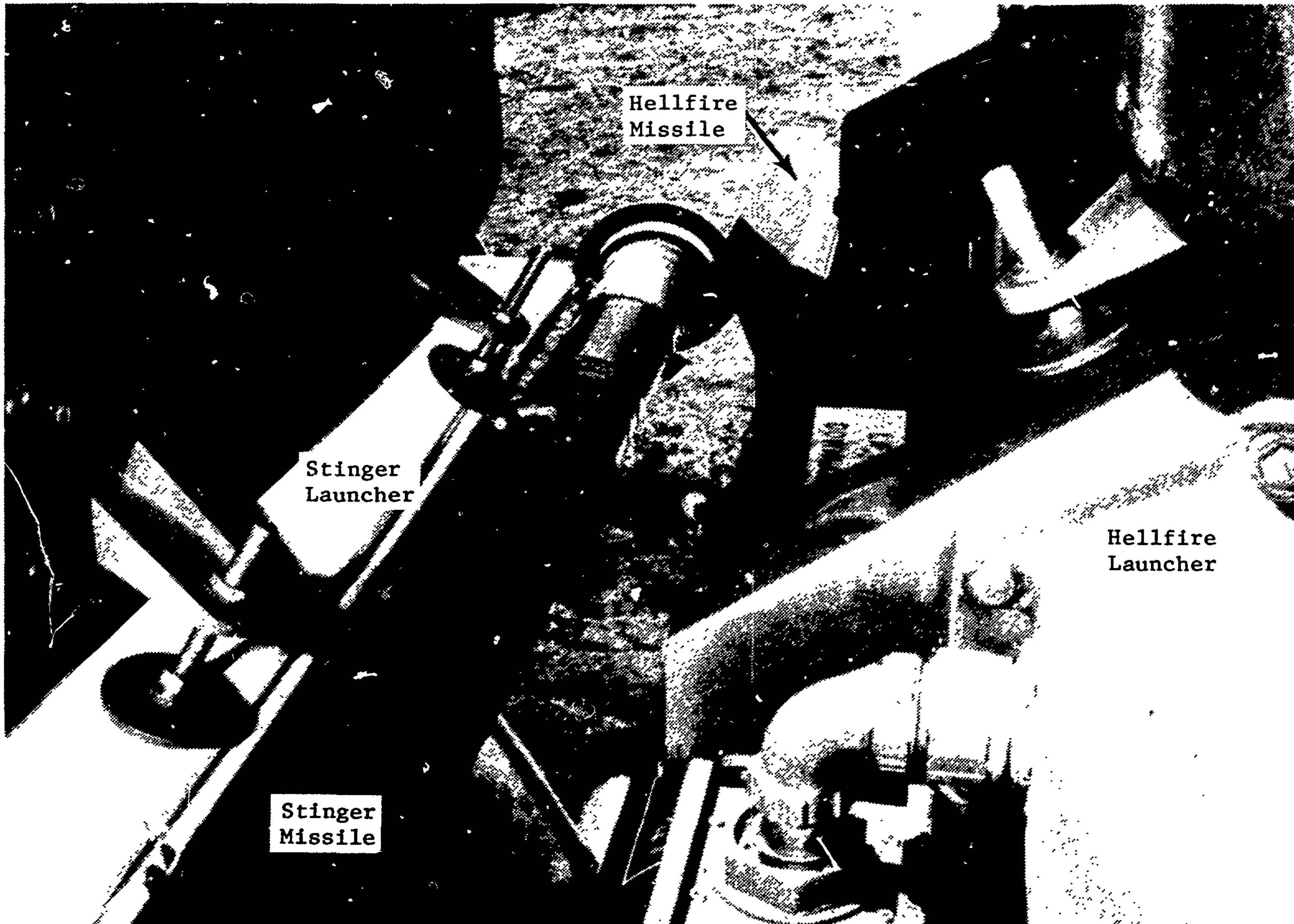



Photo 11. Front View, #1 (Left) Stinger Missile Mounted on Left Inboard Wing Station

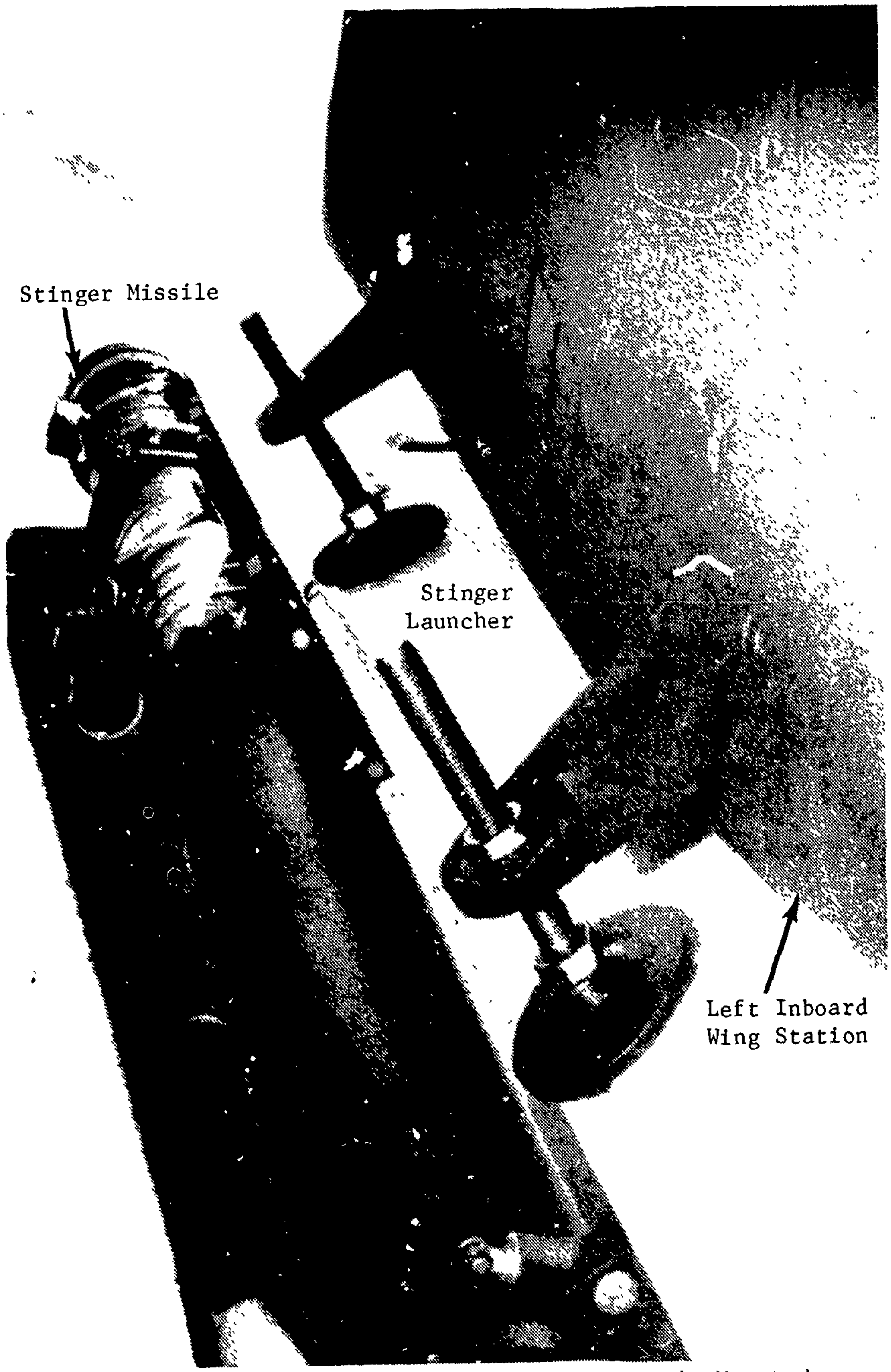



Photo 12. Rear View, #1 (Left) Stinger Missile Mounted on Left Inboard Wing Station

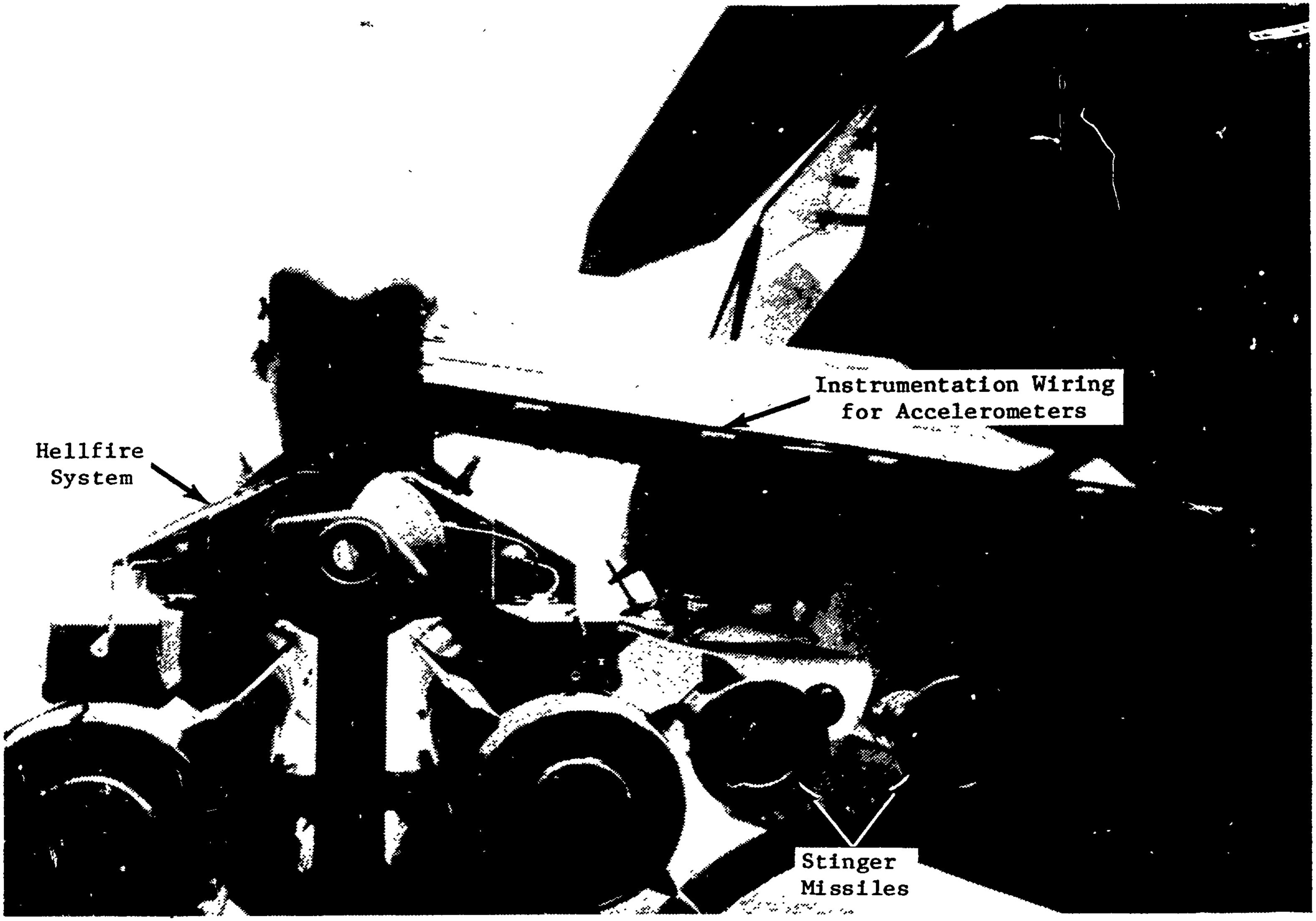



Photo 13. Rear View, Stinger and Hellfire Systems Mounted on Left Wing

## PRINCIPAL DIMENSIONS

8. The principal and general data concerning the AH-1S (MC) helicopter are as follows:

### Overall Dimensions

| | |
|---|---|
| Length, rotor turning | 53 ft, 1 in. |
| Width, rotor turning | 44 ft |
| Height, tail rotor turning | 13 ft, 9 in. |

### Main Rotor (K747 IMRB)

| | |
|---|---|
| Diameter | 44 ft |
| Disc area | 1520.53 $ft^2$ |
| Solidity | 0.0625 |
| Planform | Trapezoidal chord 30.0 in. tapering to 10.0 in. at tip. |
| Blade twist | -0.556 deg/ft |
| Normal main rotor speed | 324 RPM (100%) |

### Tail Rotor

| | |
|---|---|
| Diameter | 8 ft, 6 in. |
| Disc area | 56.75 $ft^2$ |
| Solidity | 0.1436 |
| Number of blades | 2 |
| Blade chord, constant | 11.5 in. |
| Blade twist | 0.0 deg/ft |
| Airfoil | NACA 0018 at the blade root changing linearly to a special cambered section at 8.27 percent of the tip |
| Tail rotor speed | 1655.1 RPM (100%) |

### Fuselage

| | |
|---|---|
| Length, rotor removed | 44 ft, 7 in. |
| Height: | |
| To tip of tail fin | 10 ft, 8 in. |
| Ground to top of mast | 12 ft, 3 in. |
| Ground to top of transmission fairing | 10 ft, 2 in. |
| Width: | |
| Fuselage only | 3 ft |
| Wing span | 10 ft, 9 in. |
| Skid gear tread | 7 ft |

| | |
|---|---|
| Elevator: | |
| Span | 6 ft, 11 in. |
| Airfoil | Inverted Clark Y |
| Vertical Fin: | |
| Area | 18.5 $ft^2$ |
| Airfoil | Special cambered |
| Height | 5 ft, 6 in. |
| Wing: | |
| Span | 10 ft, 9 in. |
| Incidence | 17.0 deg |
| Airfoil (root) | NACA 0030 |
| Airfoil (tip) | NACA 0024 |

# APPENDIX C. INSTRUMENTATION

1. The test instrumentation system was designed, calibrated, installed, and maintained by US Army Aviation Engineering Flight Activity. Data were obtained from calibrated instrumentation and were recorded on magnetic tape and/or displayed in the cockpit. The digital instrumentation system consisted of transducers, signal conditioning units, a ten-bit word pulse coded modulation encoder, and an Ampex AR 700 tape recorder. Strain gages were mounted on the left wing at the upper forward-wing lug and the upper mid-wing lug to measure axial loads (photo 1). The digital data were telemetered to a ground station for in-flight monitoring. A boom extending 7 ft from the nose of the aircraft with the following sensors was mounted on the nose of the aircraft: swiveling pitot-static head, sideslip vane, angle-of-attack vane, and total-temperature probe. Boom airspeed system calibration is shown in figure 1, and the engine torque sensor system calibration is shown in figure 2. Calibrated instruments used at the pilot station are displayed in photo 2.

2. Calibrated cockpit monitored parameters and special equipment are listed below.

<u>Pilot Station and Instrument Panel</u>

Angle-of-sideslip
Airspeed (boom)
Airspeed (ship's system)
Altitude (boom)
Altitude (ship's system)
Rate of climb (ship's system)
Rotor speed (sensitive)
Engine torque
Gas generator speed ($N_1$)
Power turbine speed ($N_2$)
Measured gas temperature (TGT)
Angle-of-sideslip
Outside air temperature (ship's system)
Event switch
Lateral accelerometer

<u>Copilot/Engineer Station and Instrument Panel</u>

Airspeed (ship's system)
Altitude (ship's system)
Rotor speed (sensitive)
Engine torque (sensitive)
Fuel used (totalizer)
Fuel flow
Gas generator, speed ($N_1$)

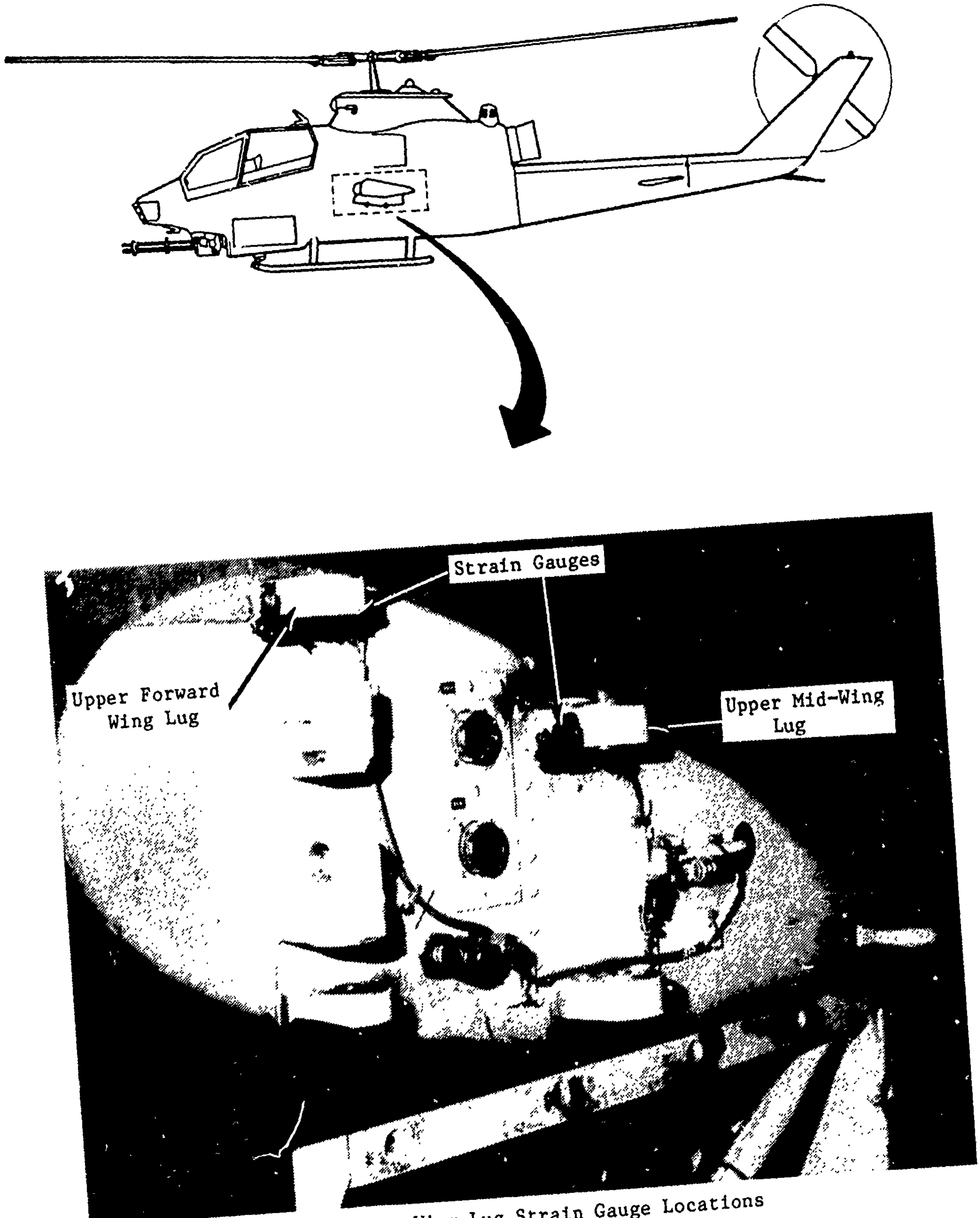



Photo 1. Wing Lug Strain Gauge Locations

FIGURE 1
BOOM AIRSPEED CALIBRATION
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 8870 | 198.0(MID) | 0.0 | 3600 | 4.0 | 321 | LEVEL |

NOTES: 1. TRAILING BOMB METHOD
2. ZERO SIDESLIP

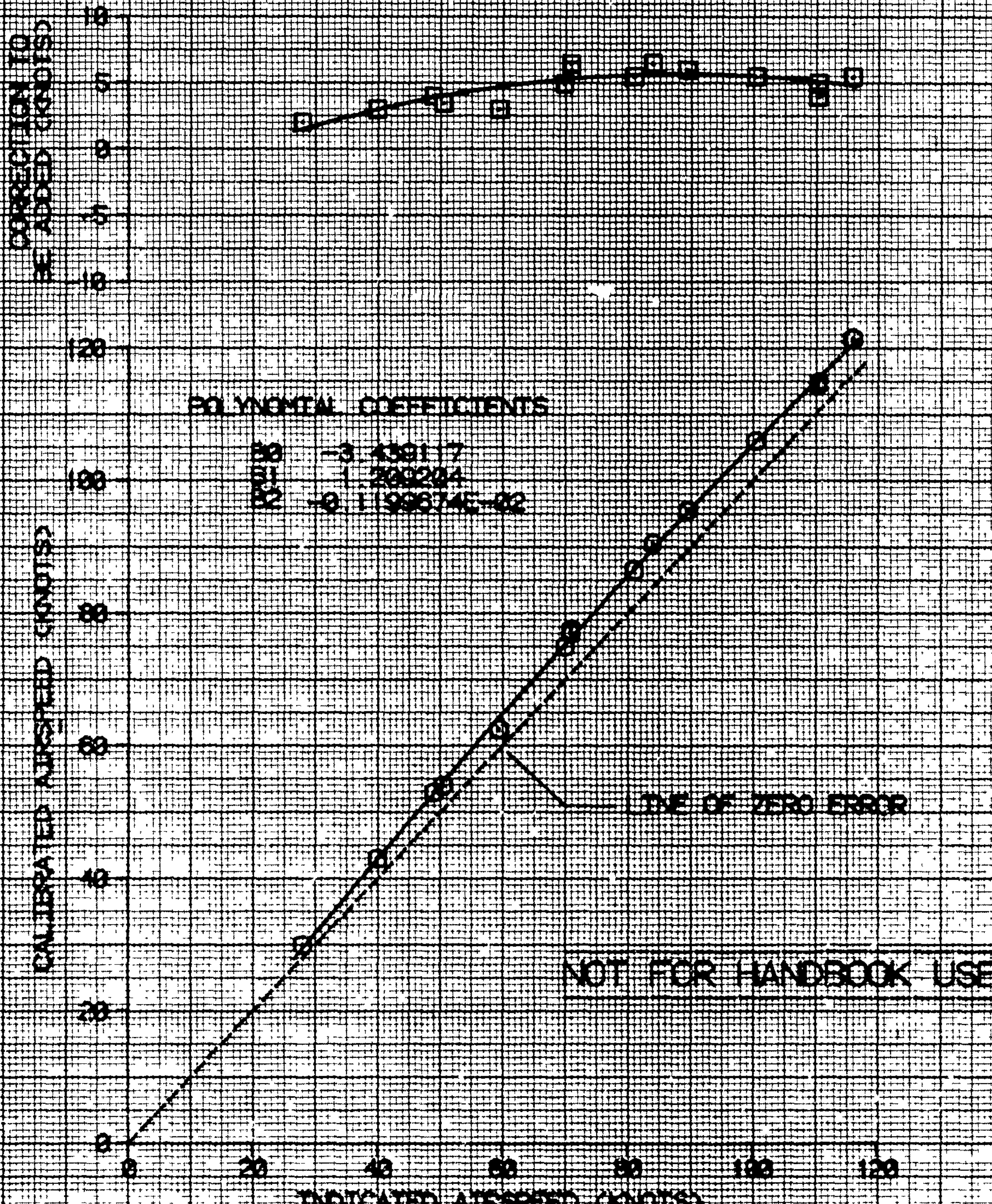


FIGURE 2

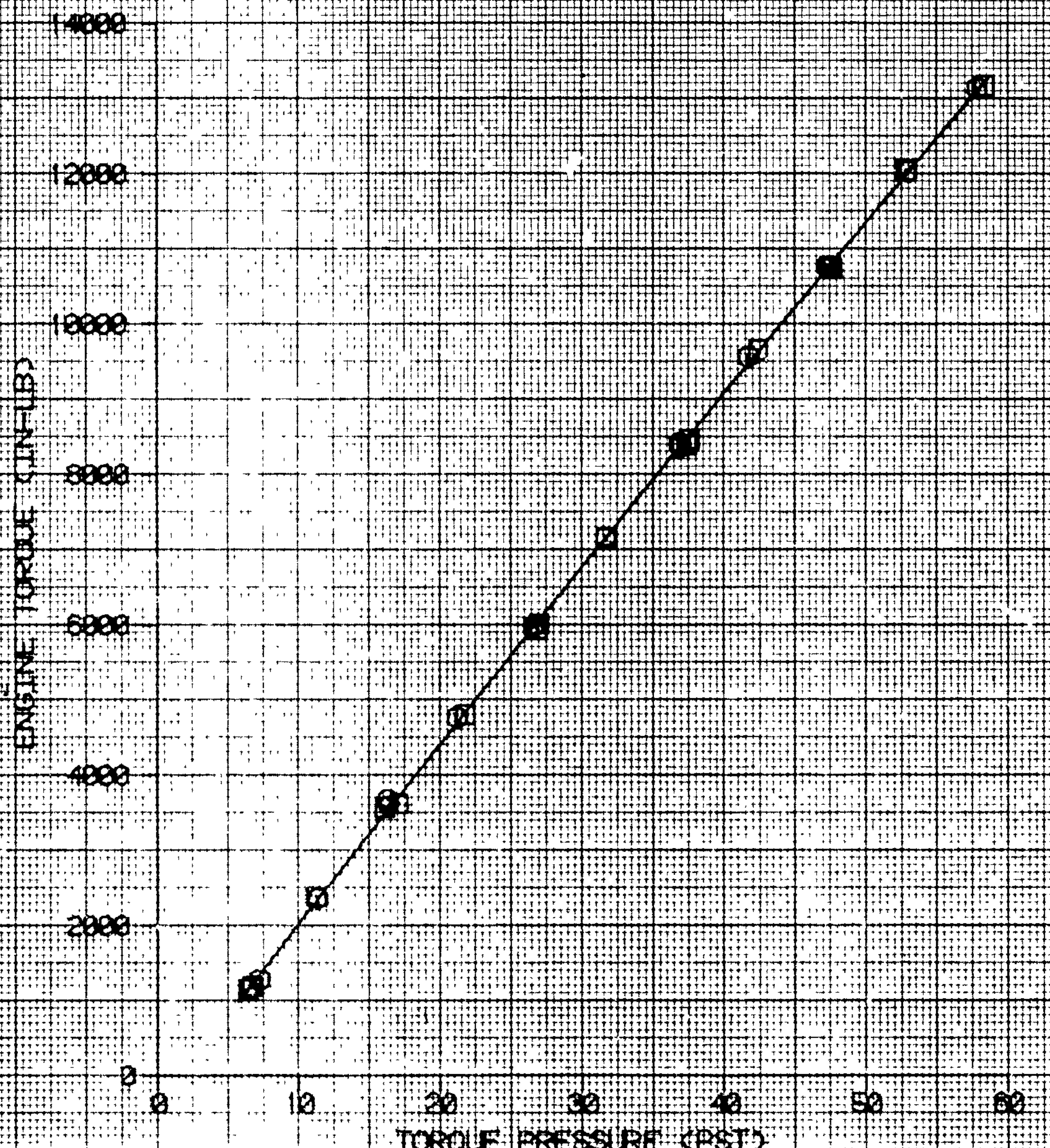
ENGINE TORQUEMETER CALIBRATION

LYCOMING ENGINE MODEL T53-L-703 S/N LE09807Z

NOTES: 1. TORQUEMETER CALIBRATION DATA FROM CORPUS CHRISTI ARMY DEPOT TEST CONDUCTED 2 MARCH 1984.
2. N2 SPEED: □ 6400 RPM
○ 6600 RPM
3. TORQUE PRESSURE BASED ON TORQUEMETER PRESSURE MINUS GEARBOX PRESSURE.

POLYNOMIAL COEFFICIENTS

B0 -414.5010
B1 245.3151
B2 -0.2042335



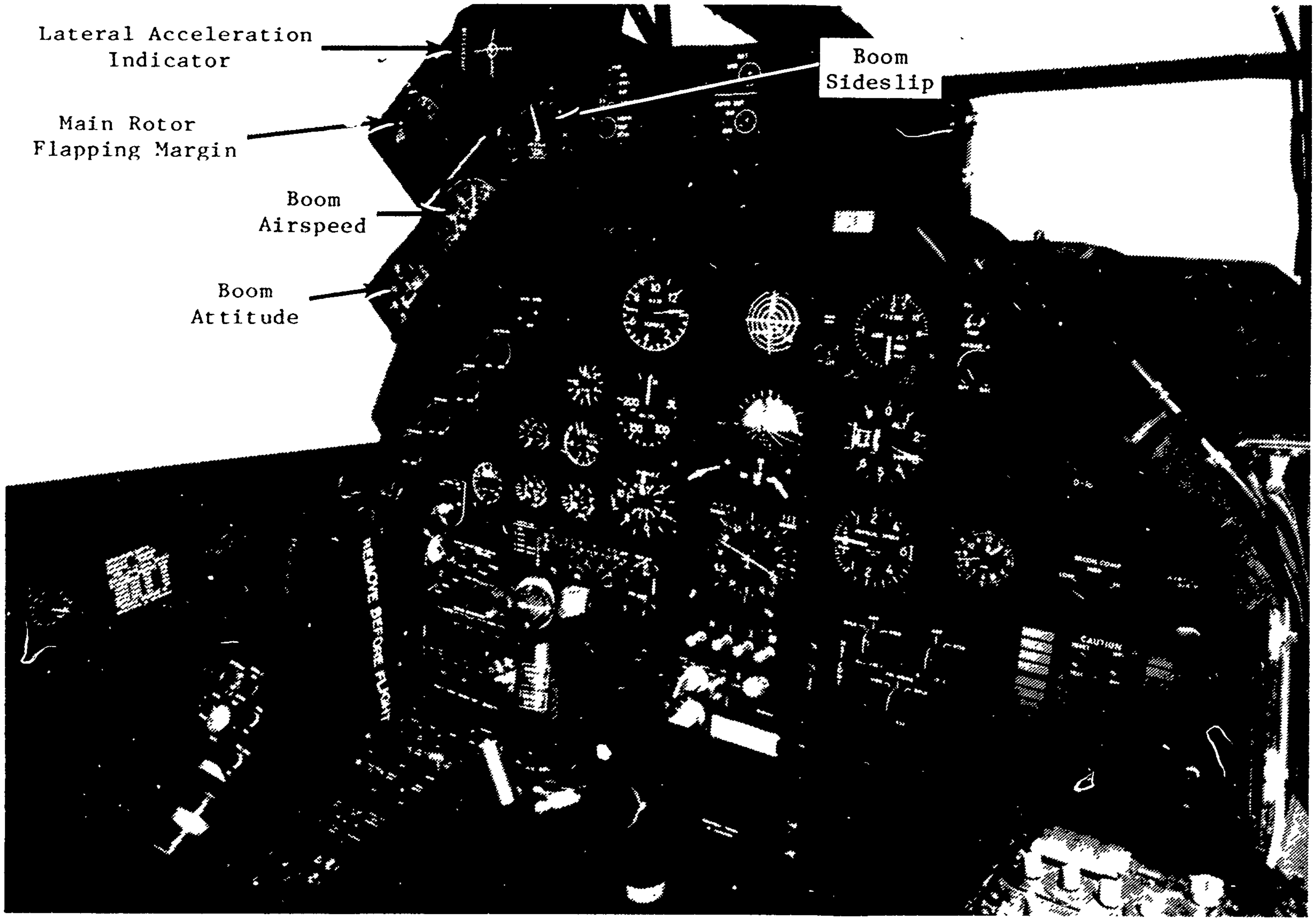



Photo 2. Right Quartering View, Pilot Instrument Panel

Measured gas temperature (TGT)
Time Code
Total air temperature (boom)
Event switch
Instrumentation controls and displays

3. Parameters recorded on magnetic tape were as follows:

<u>PCM Parameters</u>

Airspeed (boom)
Airspeed (ship's system)
Altitude (boom)
Altitude (ship's system)
Angle-of-attack
Rotor speed
Engine torque
Fuel used
Fuel flow
Gas generator speed ($N_1$)
Power turbine speed ($N_2$)
Measured gas temperature
Control position
    Longitudinal
    Lateral
    Directional
    Collective
SCAS Actuator Positions
    Longitudinal
    Lateral
    Directional
Attitude
    Pitch
    Roll
    Yaw
Angular Rate
    Pitch
    Roll
    Yaw
Angle-of-sideslip
Main rotor flapping angle
Rotor azimuth blip
Left wing upper forward lug axial load
Left wing upper mid lug axial load
Pilot/engineer event
Time Code
Record number
Outside air temperature (boom)

Center of gravity accelerations
  Longitudinal
  Lateral
  Vertical
Vertical pilot seat acceleration
Vertical acceleration at the extreme forward and aft positions on the Hellfire upper launcher rack

Other Instrumentation

SCAS hardover control box for roll axis

# APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

## GENERAL

1. Performance data were obtained using the basic methods described in Army Material Command Pamphlet AMCP 706-204 (ref 9, app A). Performance testing was conducted in ball-centered flight. Handling qualities data were evaluated using standard test methods described in Naval Air Test Center Flight Test Manual FTM No. 101 (ref 10).

## AIRCRAFT WEIGHT AND BALANCE

2. The aircraft was weighed in the clean instrumented configuration and in all five armament configurations with full oil and trapped fuel prior to the start of this program. The weight of the clean instrumented aircraft was 7468 lb with the longitudinal center of gravity (cg) located at fuselage station (FS) 200.9. The fuel cells and an external sight gage were also calibrated. The measured fuel capacity using the gravity fueling method was 254.4 gallons. The fuel weight for each test flight was determined prior to engine start and after engine shutdown by using the external sight gage to determine the volume and measuring the specific gravity of the fuel. The calibrated cockpit fuel totalizer indicator was used during the test, and at the end of each test was compared with the sight gage readings.

## PERFORMANCE

### General

3. Helicopter performance was generalized through the use of nondimensional coefficients as follows using the 1968 US Standard Atmosphere:

a. Coefficient of Power ($C_P$):

$$C_P = \frac{SHP\ (550)}{\rho A(\Omega R)^3} \tag{1}$$

b. Coefficient of Thrust ($C_T$):

$$C_T = \frac{GW}{\rho A(\Omega R)^2} \tag{2}$$

c. Advance Ratio ($\mu$):

$$\mu = \frac{V_T(1.6878)}{\Omega R} \qquad (3)$$

Where:

SHP = Engine output shaft horsepower

$\rho$ = Ambient air density ($lb\text{-}sec^2/ft^4$)

A = Main rotor disc area = 1520.53 $ft^2$

$\Omega$ = Main rotor angular velocity (radians/sec) = $\frac{2\pi}{60}$ x RPM

R = Main rotor radius = 22.0 ft

GW = Gross weight (lb)

$V_T$ = True airspeed (kt) = $\dfrac{V_E}{1.6878\sqrt{\rho/\rho_o}}$

1.6878 = Conversion factor (ft/sec-kt)

$\rho_o$ = 0.0023769 ($lb\text{-}sec^2/ft^4$)

$V_E$ = Equivalent airspeed (ft/sec) =

$$\left(\frac{7\ (70.7262\ P_a)}{\rho_o}\left(\left(\frac{Q_c}{P_a}+1\right)^{2/7}-1\right)\right)^{1/2}$$

70.7262 = Conversion factor ($lb/ft^2$ -in. -Hg)

$Q_c$ = Dynamic pressure (in. -Hg)

$P_a$ = Ambient air pressure (in. -Hg)

At the nominal operating rotor speed of 324 RPM (100%) the following constants may be used to calculate $C_P$ and $C_T$:

$$\Omega R = 746.44 \quad \text{ft/sec}$$

$$A(\Omega R)^2 = 847{,}197{,}765.2 \quad \text{ft}^4/\text{sec}^2$$

$$\frac{A(\Omega R)^3}{550} = 1{,}149{,}786{,}000.0 \quad \frac{\text{SHP ft}^4}{\text{lb sec}^2}$$

4. The engine output shaft torque was determined by use of the engine manufacturer's torque system and using the calibration obtained at Corpus Christi Army Depot on 2 March 1984 (fig. 1, app C). The output shaft horsepower (SHP) was determined from the engine shaft torque and rotational speed by equation (4).

$$SHP = \frac{Q(N_p)}{5252.113} \tag{4}$$

Where:

Q = Engine output shaft torque (ft-lb)

$N_p$ = Engine output s' rotational speed (rpm)

5252.113 = Conversion factor (ft-lb-rev/min-SHP)

## Level Flight Performance

5. Level flight performance was determined by using equations 1 through 3, rewritten in the following format.

$$C_p = \frac{SHP\ (478935.3)}{\delta\sqrt{\theta}\left(\frac{N_R}{\sqrt{\theta}}\right)^3 (\rho_o A R^3)} \tag{5}$$

$$C_T = \frac{GW\ (91.19)}{\delta\left(\frac{N_R}{\sqrt{\theta}}\right)^2 (\rho_o A R^2)} \tag{6}$$

$$\mu = \frac{V_T \quad (16.12)}{(R\sqrt{\theta}) \quad \frac{N_R}{\sqrt{\theta}}} \tag{7}$$

Where:

$\delta$ = Pressure ratio = $\dfrac{P_a}{P_{a_o}}$

$P_{a_o}$ = 29.92126 in. -Hg

$\theta$ = Temperature ratio = $\dfrac{OAT + 273.15}{288.15}$

OAT = Ambient air temperature (°C)

$N_R$ = Main rotor speed (rev/min)

$\sigma = \delta/\theta$

478935.3 = Conversion factor (ft-lb-sec$^2$ -rev$^3$/min$^3$-SHP)

91.19 = Conversion factor (sec$^2$-rev$^2$/min$^2$)

16.12 = Conversion factor (ft-rev/min-kt)

Changes in horsepower due to changes in flat plate area were determined from the following equation:

$$\Delta SHP = \frac{(\Delta F_e)(\sigma)(V_T{}^3)}{96254} \tag{8}$$

Where:

$\Delta F_e$ = Change in equivalent flat plate area (ft$^2$)

96254 = Conve 'on factor (ft$^2$-kt$^3$/SHP)

6. Each speed power was flown in ball-centered flight by reference to lateral acceleration indicator at a predetermined coefficient of thrust ($C_T$) and referred rotor speed ($N_R/\sqrt{\theta}$). To maintain the ratio of gross weight to pressure ratio ($W/\delta$) constant, altitude was increased as fuel was consumed. To maintain $N_R/\sqrt{\theta}$ constant, rotor speed was changed as temperature changed.

7. Test-day level flight data was corrected to a referred rotor speed of 316 rpm and to standard day conditions by the following equations:

$$SHP_s = SHP_t \frac{(\delta_s \sqrt{\theta_s}) \left(\frac{N_R}{\sqrt{\theta}}\right)_s^3}{(\delta_t \sqrt{\theta_t}) \left(\frac{N_R}{\sqrt{\theta}}\right)_t^3} \tag{9}$$

$$V_{T_s} = V_{T_t} \frac{\left(\frac{N_R}{\sqrt{\theta}}\right)_s}{\left(\frac{N_R}{\sqrt{\theta}}\right)_t} \tag{10}$$

where:

subscript s = standard day conditions
subscript t = test day conditions

8. The data obtained were analyzed by use of a carpet plot ($C_T$ and $\mu$ versus $C_P$) for each configuration. From this carpet plot a family of curves of $C_T$ versus $C_P$ for a constant $\mu$ value was obtained which allowed determination of the power required as a function of airspeed for any value of $C_T$. The data obtained in the various armament configurations were compared with data obtained with the clean aircraft as a function of airspeed to determining the change in equivalent flat plate area for each configuration.

9. The curve denoting specific range in nautical air miles per pounds of fuel was derived from the engine specifications for the Lycoming T53-L-703 (ref 14).

## HANDLING QUALITIES

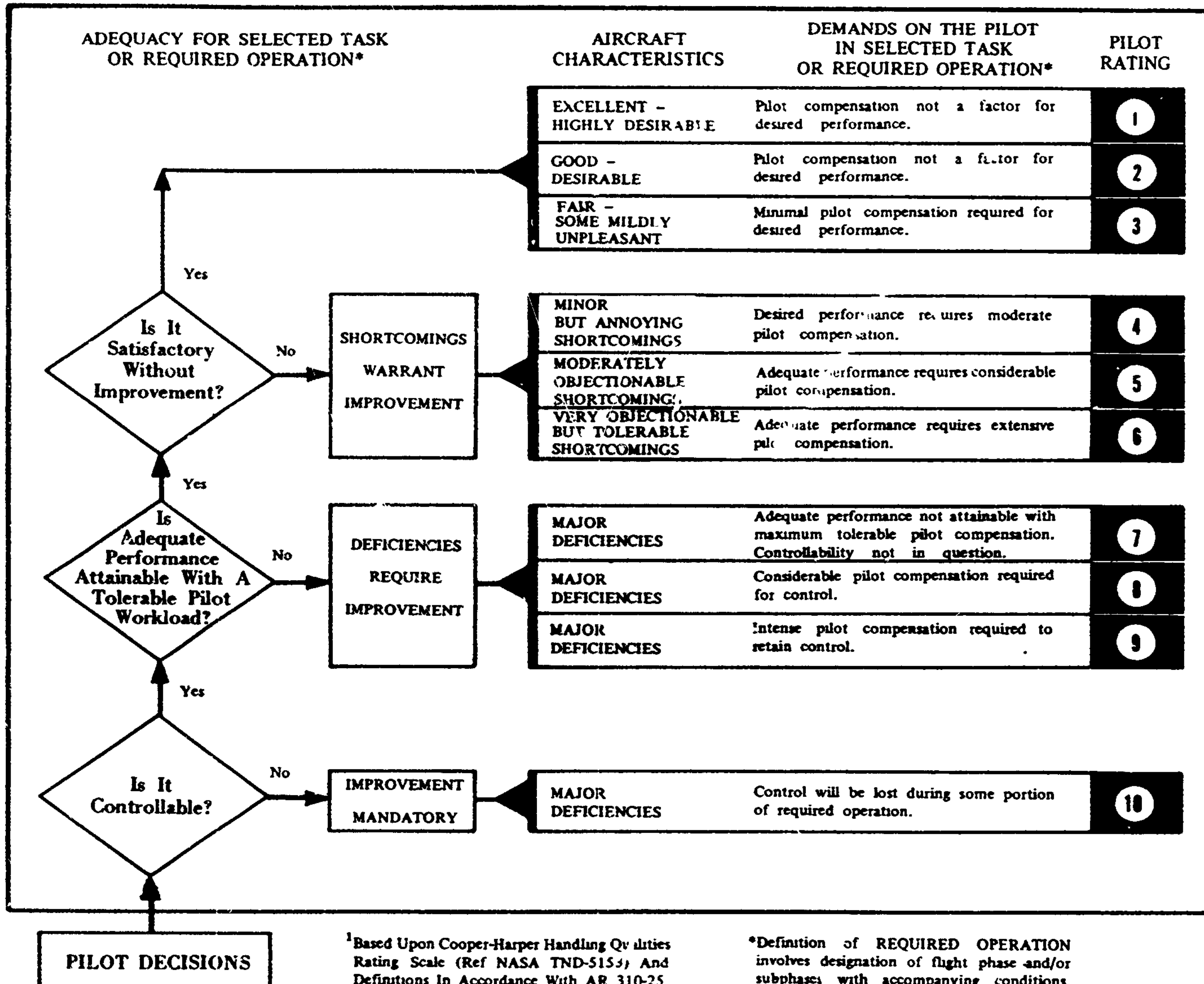
10. Stability and control data were collected and evaluated using standard test methods described in reference 5, appendix A. The Handling Qualities Rating Scale (HQRS) presented in figure 1 was used to augment pilot comments relative to handling qualities.

## VIBRATION

11. Vibrations were quantitatively evaluated and the Vibration Rating Scale presented in figure 2 was used to augment crew comments on aircraft vibration levels.

## DEFINITION

12. The definition of shortcoming as used in this report is as follows: an imperfection or malfunction during the life cycle of equipment, which must be reported and which should be corrected to increase efficiency and to render the equipment completely serviceable. It will not cause an immediate breakdown, jeopardize safe operation, or materially reduce the usability of the material or end product.




[1]Based Upon Cooper-Harper Handling Qualities Rating Scale (Ref NASA TND-5153) And Definitions In Accordance With AR 310-25

*Definition of REQUIRED OPERATION involves designation of flight phase and/or subphases with accompanying conditions.

Figure 1. Handling Qualities Rating Scale

| DEGREE OF VIBRATION | DESCRIPTION[1] | PILOT RATING |
|---|---|---|
| No vibration | | 0 |
| Slight | Not apparent to experienced aircrew fully occupied by their tasks, but noticeable if their attention is directed to it or if not otherwise occupied. | 1, 2, 3 |
| Moderate | Experienced aircrew are aware of the vibration but it does not affect their work, at least over a short period. | 4, 5, 6 |
| Severe | Vibration is immediately apparent to experienced aircrew even when fully occupied. Performance of primary task is affected or tasks can only be done with difficulty. | 7, 8, 9 |
| Intolerable | Sole preoccupation of aircrew is to reduce vibration level. | 10 |

[1] Based upon the Subjective Vibration Assessment Scale developed by the Aeroplane and Armament Experimental Establishment, Boscombe Down, England.

Figure 2. Vibration Rating Scale

# APPENDIX E. TEST DATA

INDEX


| Figure | Figure Number |
|---|---|
| Level Flight Performance | 1 through 39 |
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| Static Longitudinal Stability | 46 through 51 |
| Static Lateral-Directinal Stability | 52 through 57 |
| Maneuvering Stability | 58 through 61 |
| Dynamic Stability | 62 through 74 |
| Low Speed Flight Characteristics | 75 through 82 |
| Simulated Engine Failures | 83 through 86 |
| SCAS Failures | 87 through 100 |
| Vibration Characteristics | 101 through 117 |

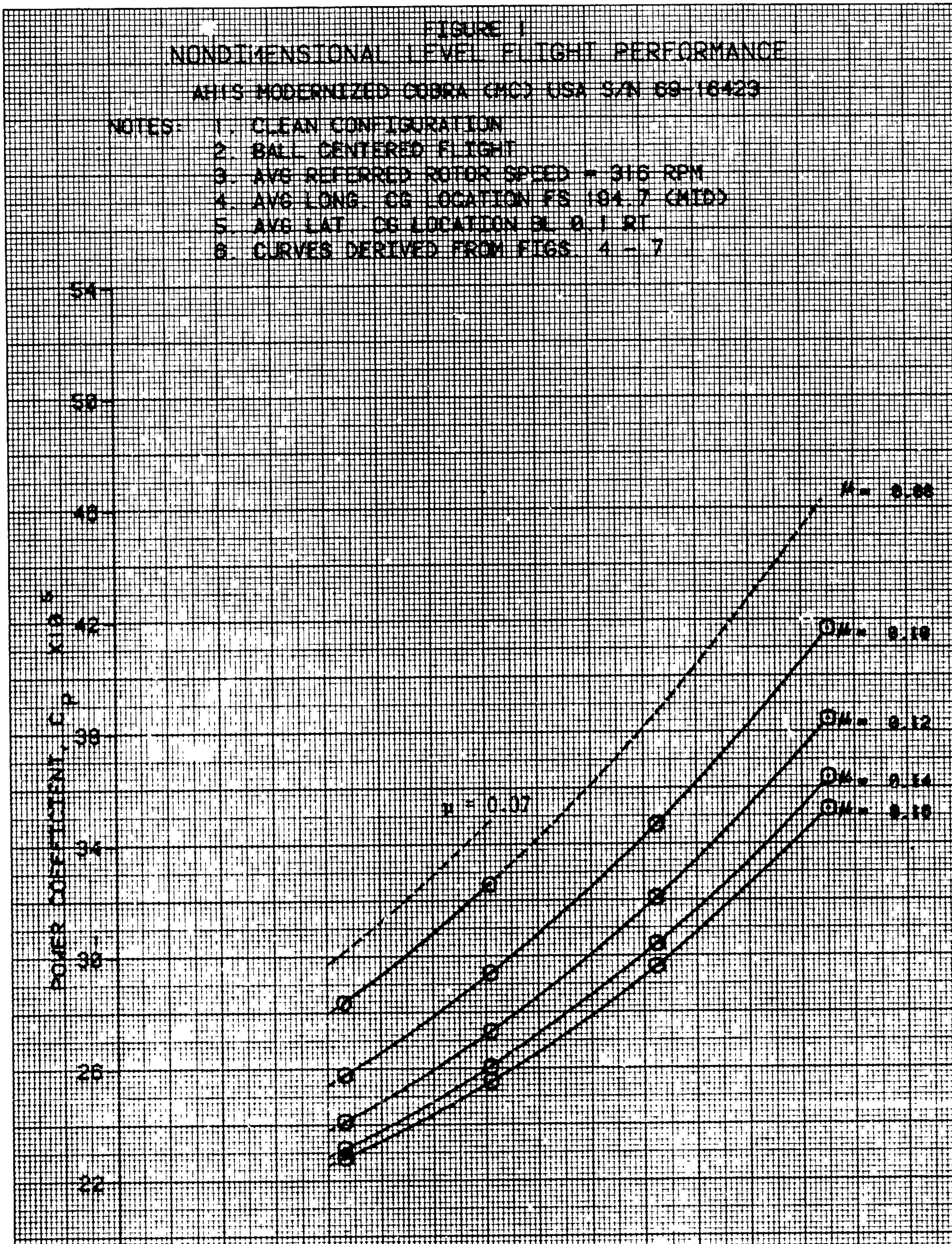


FIGURE 1
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
NOTES: 1. CLEAN CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.7 (MID)
5. AVG LAT. CG LOCATION BL 0.1 RT
6. CURVES DERIVED FROM FIGS. 4 - 7
μ = 0.08
μ = 0.10
μ = 0.12
μ = 0.14
μ = 0.16
μ = 0.07
POWER COEFFICIENT, $C_P$ X10$^{-5}$
THRUST COEFFICIENT, $C_T$ X10$^{-4}$
54
50
46
42
38
34
30
26
22
18
42
46
50
54
58
62
66
70

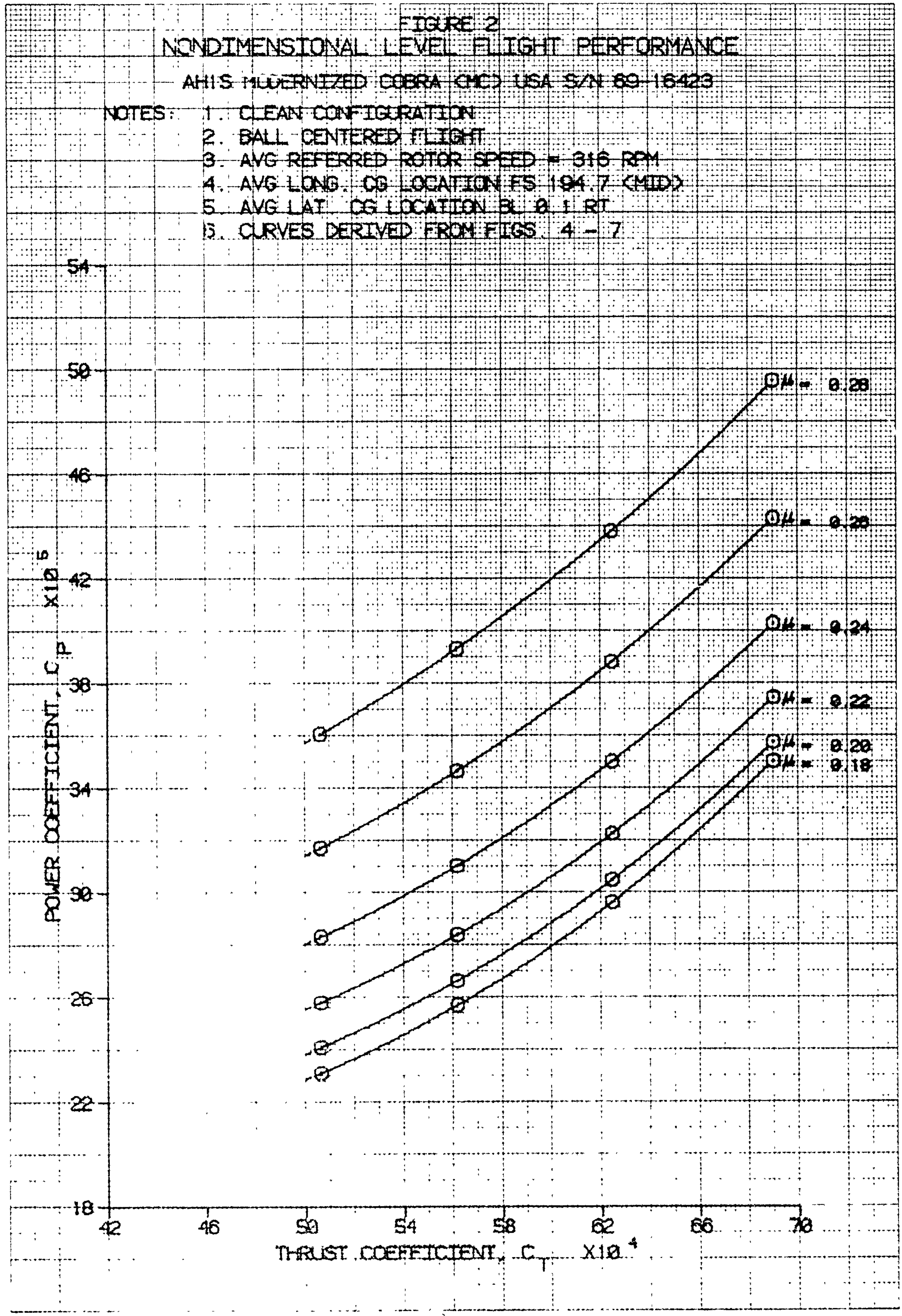


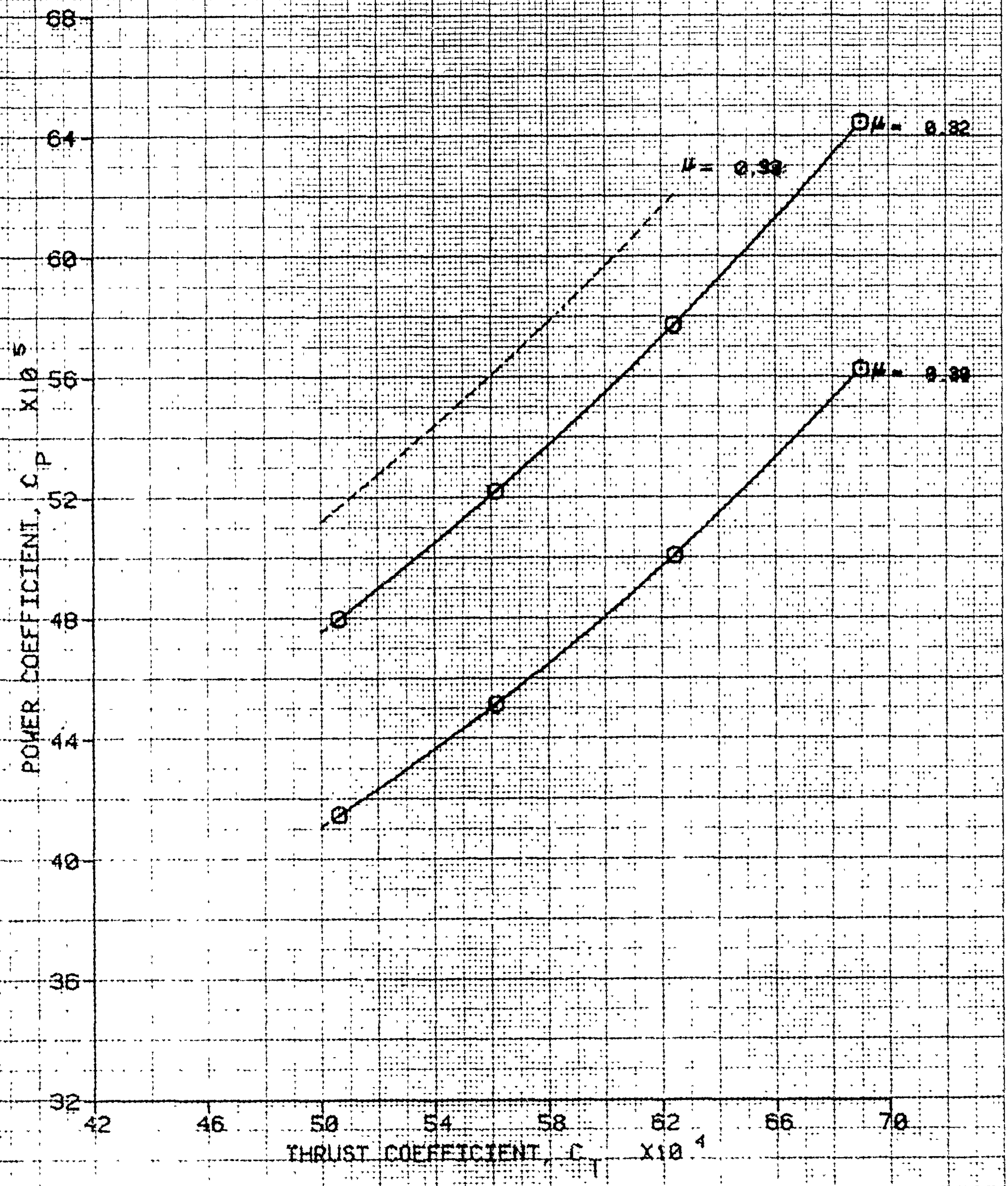
FIGURE 2
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
NOTES: 1. CLEAN CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.7 (MID)
5. AVG LAT. CG LOCATION BL 0.1 RT
6. CURVES DERIVED FROM FIGS. 4 - 7
μ = 0.28
μ = 0.26
μ = 0.24
μ = 0.22
μ = 0.20
μ = 0.18
POWER COEFFICIENT, $C_P$ X10$^5$
THRUST COEFFICIENT, $C_T$ X10$^4$
18
22
26
30
34
38
42
46
50
54
42
46
50
54
58
62
66
70

FIGURE 3

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. CLEAN CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.7 (MID)
5. AVG LAT. CG LOCATION BL 0.1 RT
6. CURVES DERIVED FROM FIGS. 4 - 7



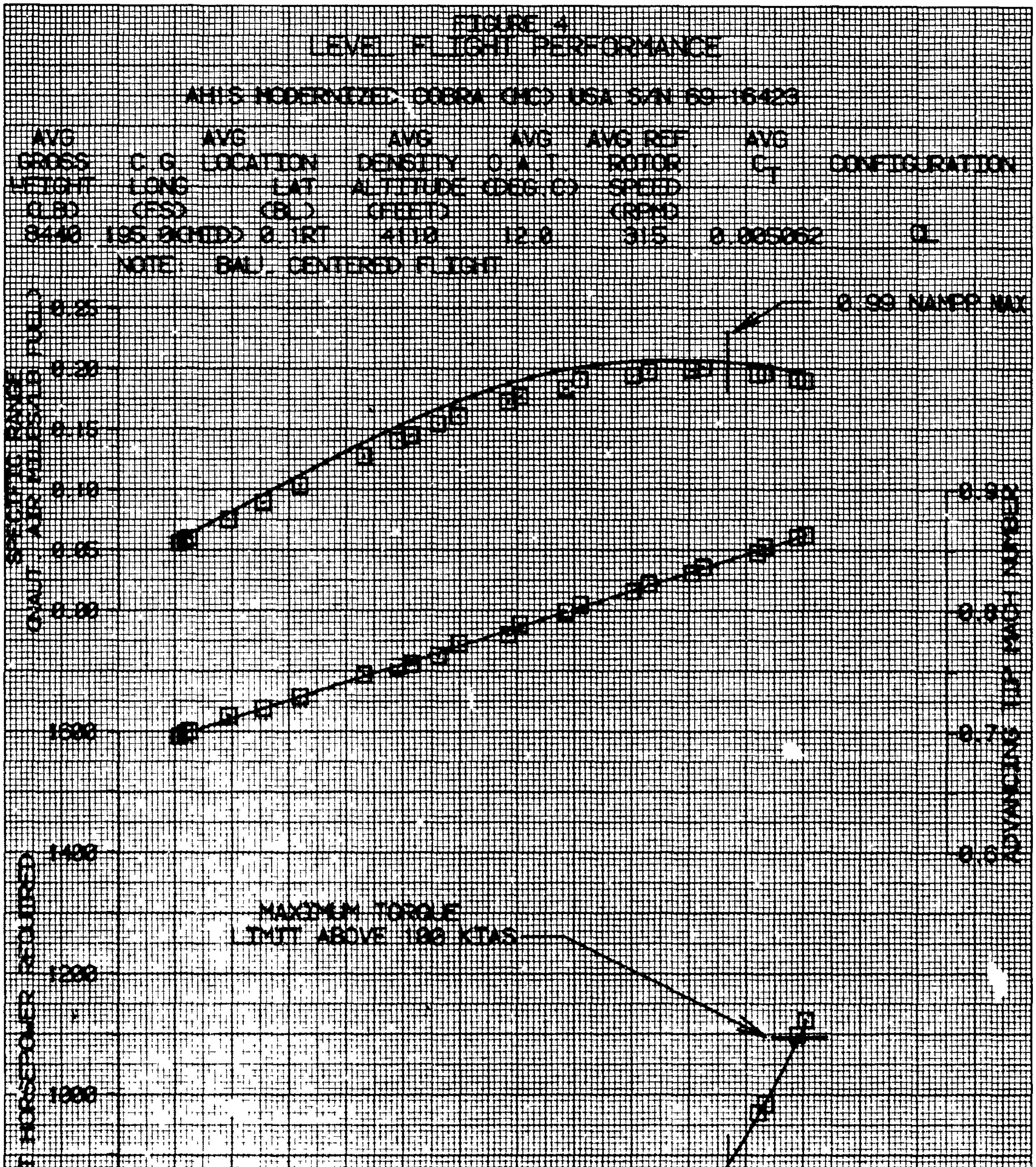



FIGURE 4
LEVEL FLIGHT PERFORMANCE

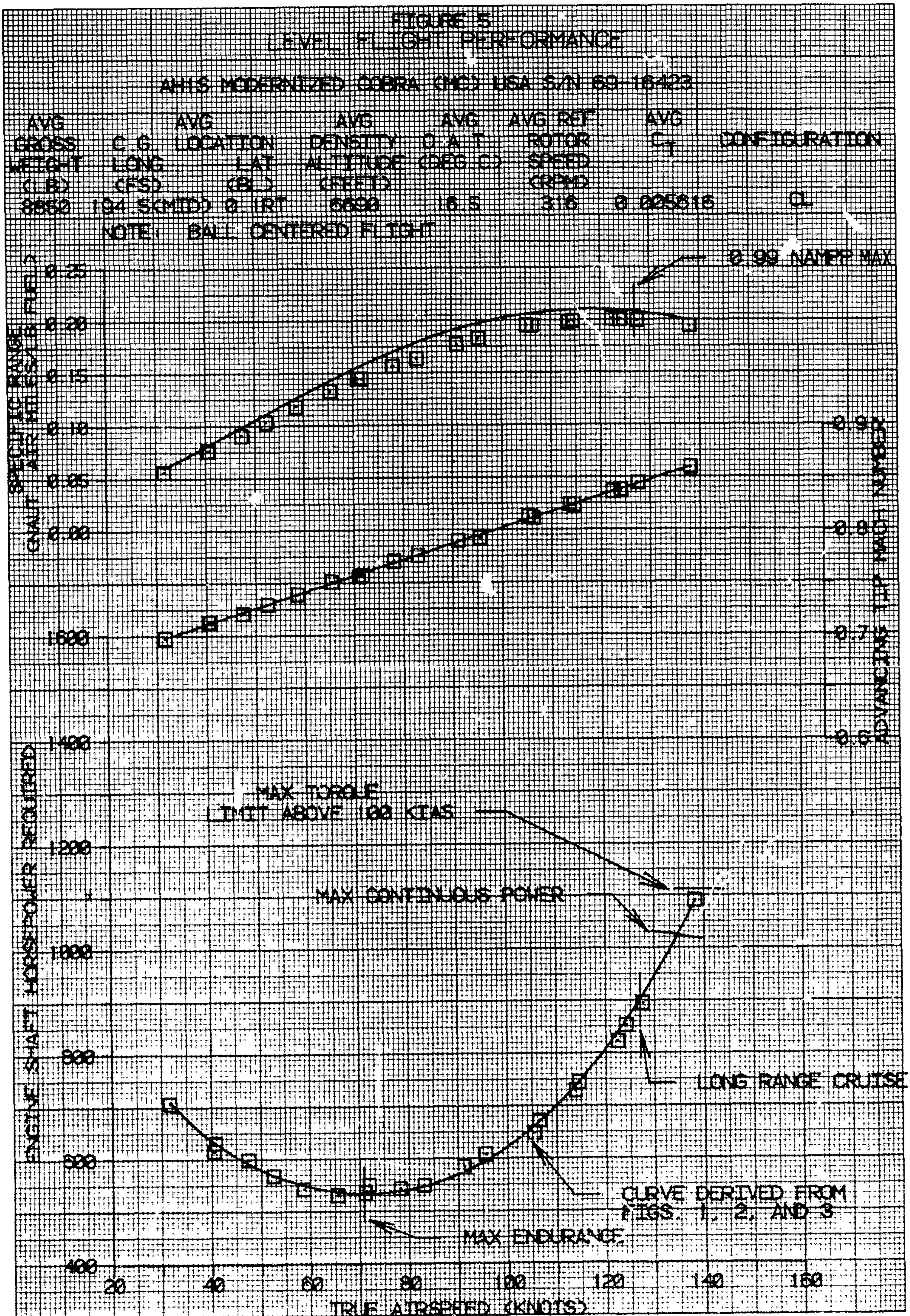


FIGURE 5
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB)
AVG C.G. LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FEET)
AVG O.A.T. (DEG C)
AVG REF. ROTOR SPEED (RPM)
AVG $C_T$
CONFIGURATION
8850 194.5(MID) 0.1RT 6690 16.5 316 0.005516 CL
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
1600
1400
1200
1000
800
600
400
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 1, 2, AND 3
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

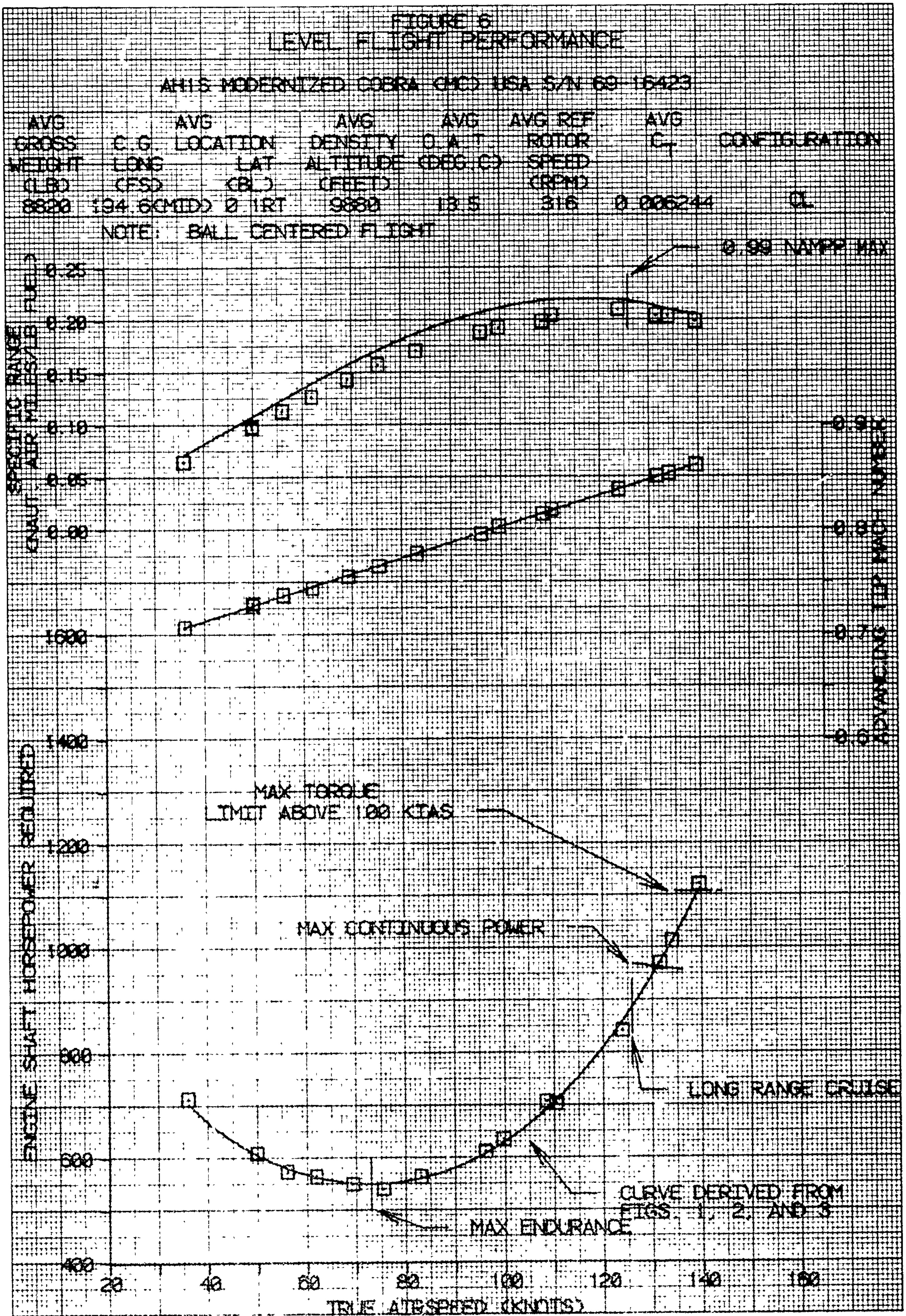


FIGURE 6
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB)
AVG C.G. LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FEET)
AVG O.A.T. (DEG.C)
AVG REF. ROTOR SPEED (RPM)
AVG C_T
CONFIGURATION
8820 194.6(MID) 0.1RT 9880 13.5 316 0.006244 CL
NOTE: BALL CENTERED FLIGHT
0.90 NAMPP MAX
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 1, 2, AND 3
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

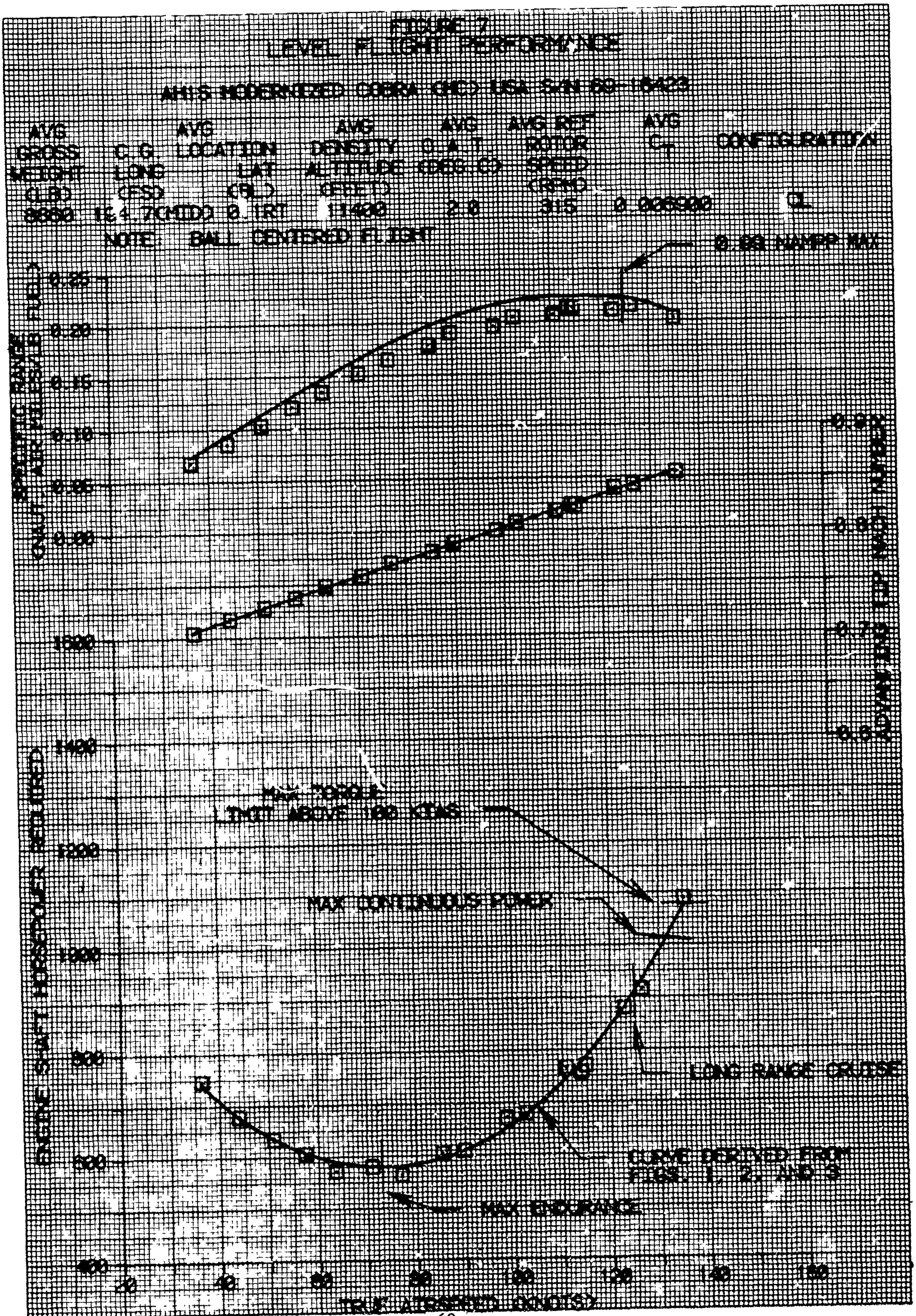


FIGURE 7
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 8860
AVG C.G. LOCATION LONG (FS) 164.7(MID) LAT (BL) 0.1RT
AVG DENSITY ALTITUDE (FEET) 11400
AVG O.A.T. (DEG C) 2.0
AVG REF. ROTOR SPEED (RPM) 315
AVG $C_T$ 0.006900
CONFIGURATION CL
NOTE: BALL CENTERED FLIGHT
0.88 NAMPP MAX
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
ENGINE SHAFT HORSEPOWER REQUIRED
ADVANCING TIP MACH NUMBER
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 1, 2, AND 3
MAX ENDURANCE
TRUE AIRSPEED (KNOTS)

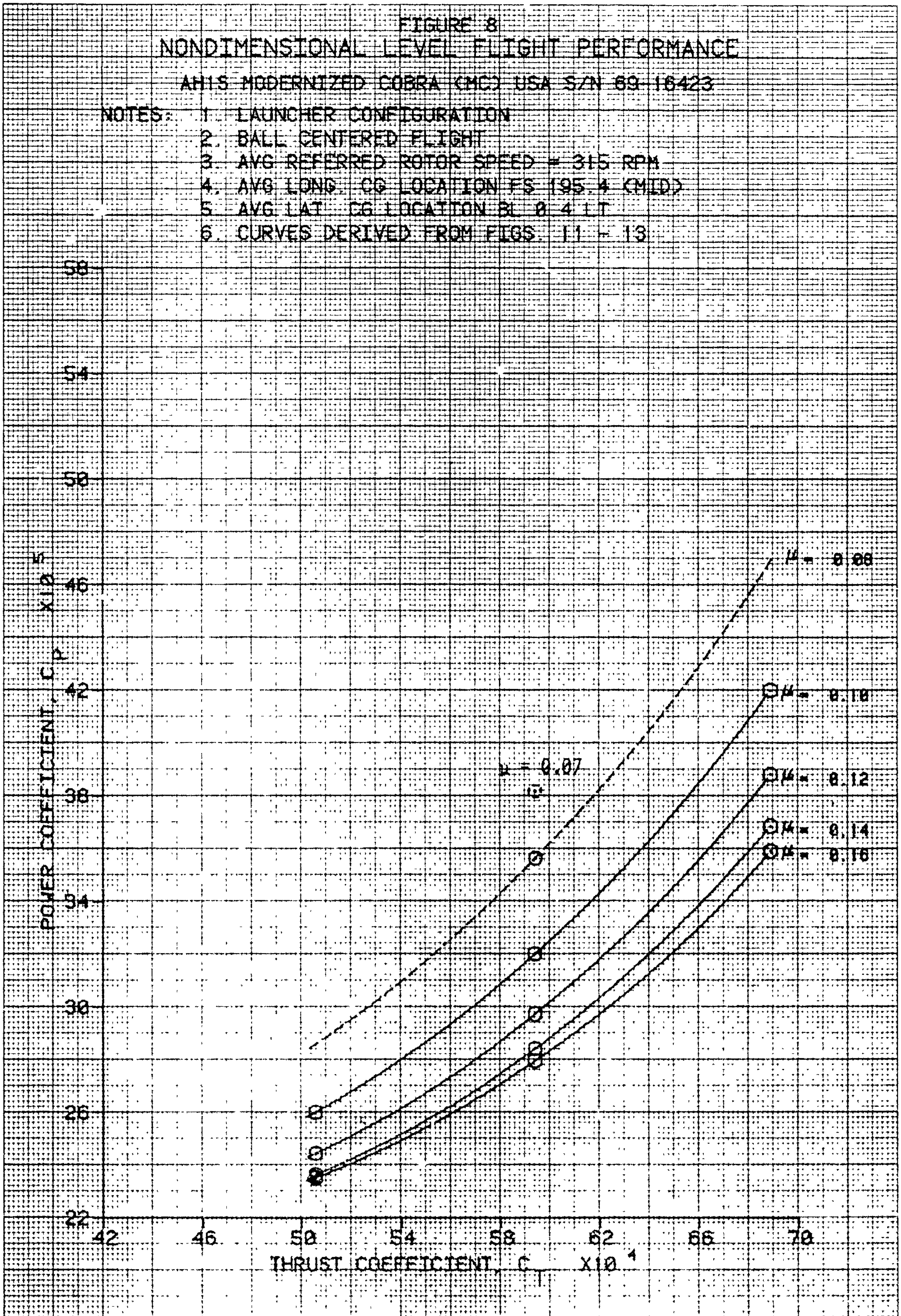


FIGURE 8
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
NOTES: 1. LAUNCHER CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 315 RPM
4. AVG LONG. CG LOCATION FS 195.4 (MID)
5. AVG LAT. CG LOCATION BL 0.4 LT
6. CURVES DERIVED FROM FIGS. 11 - 13
POWER COEFFICIENT, $C_P$ X10$^5$
THRUST COEFFICIENT, $C_T$ X10$^4$
μ = 0.08
μ = 0.10
μ = 0.12
μ = 0.14
μ = 0.16
μ = 0.07
22
26
30
34
38
42
46
50
54
58
42
46
50
54
58
62
66
70

FIGURE 9

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. LAUNCHER CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 315 RPM
4. AVG LONG. CG LOCATION FS 195.4 (MID)
5. AVG LAT. CG LOCATION BL 0.4 LT
6. CURVES DERIVED FROM FIGS. 11 - 13

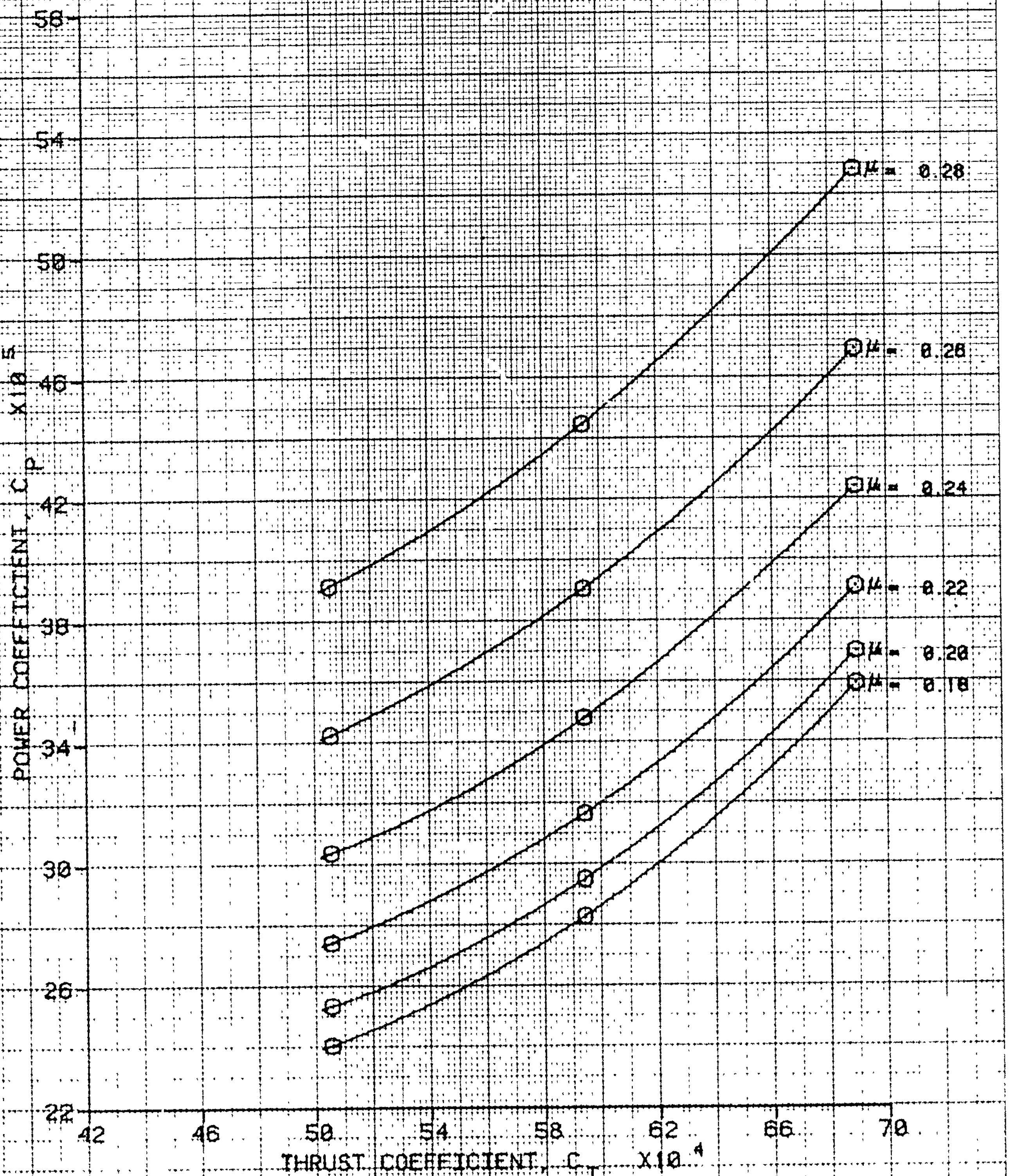


FIGURE 10
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 66-16423

NOTES:
1. LAUNCHER CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 315 RPM
4. AVG LONG. CG LOCATION FS 195.4 (MID)
5. AVG LAT. CG LOCATION BL 0.4 LT
6. CURVES DERIVED FROM FIGS. 11 - 13

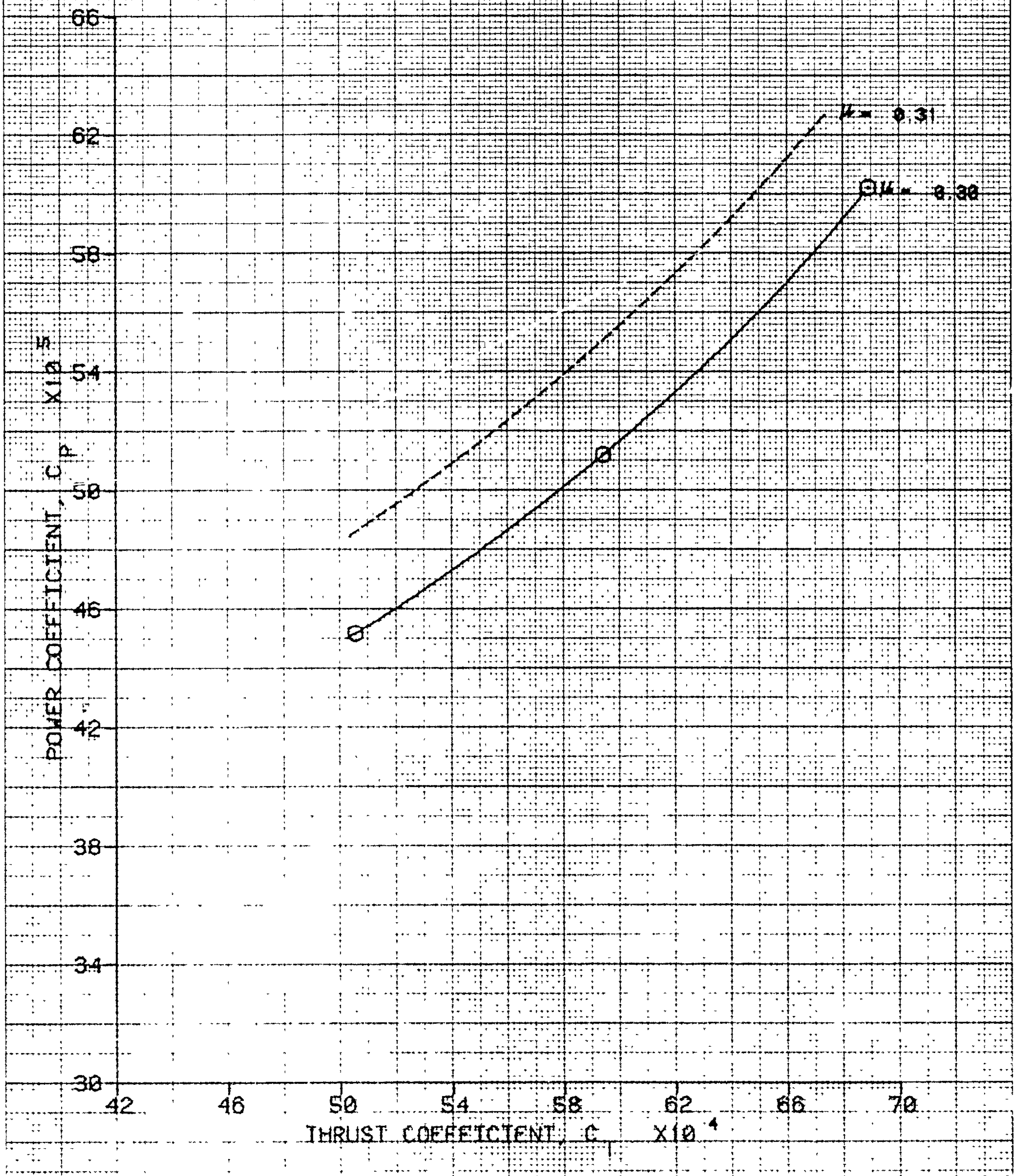
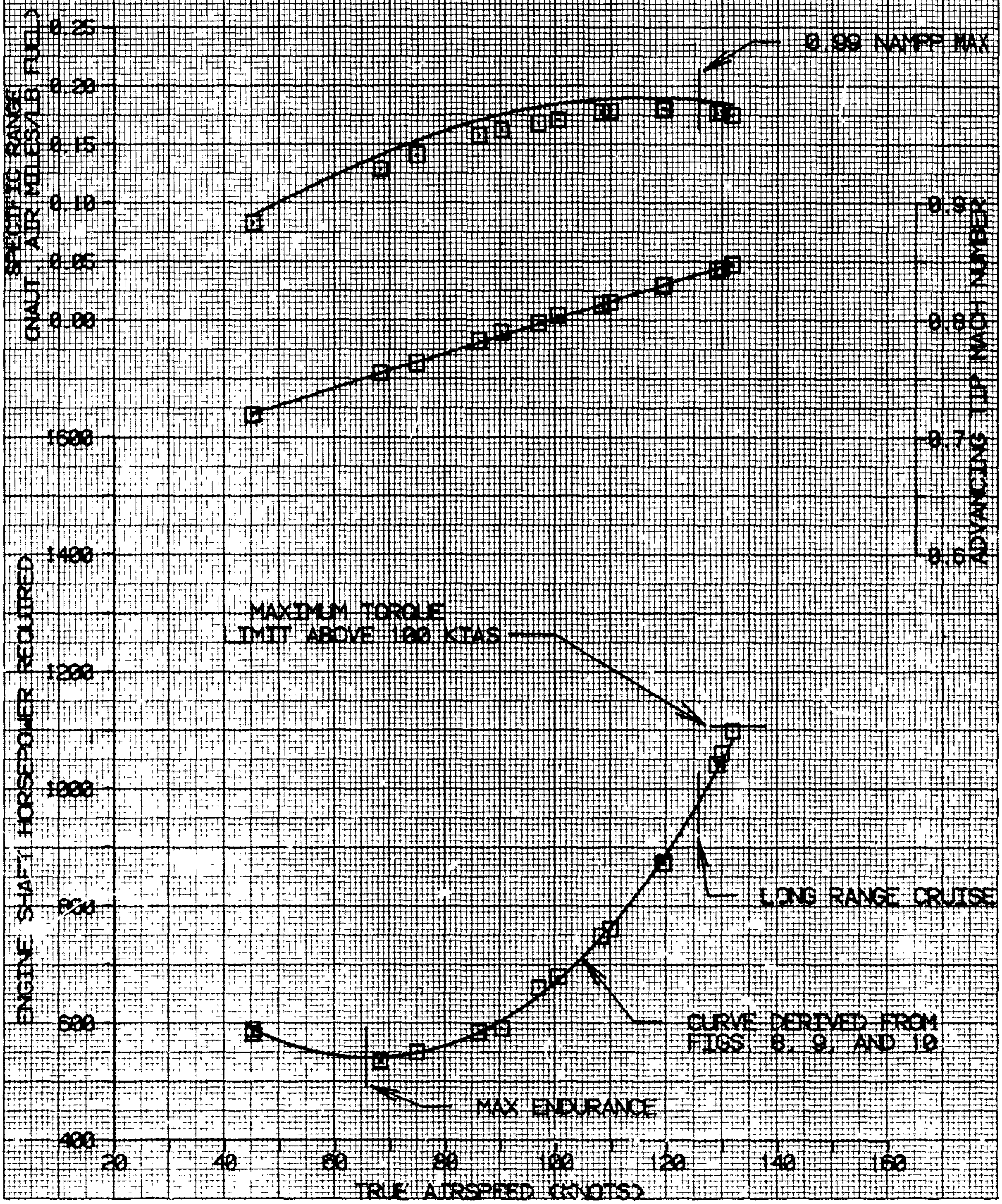


FIGURE 11
LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG C.G. LOCATION LONG (FS) | AVG C.G. LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG O.A.T. (DEG C) | AVG REF. ROTOR SPEED (RPM) | AVG $C_T$ | CONFIGURATION |
|---|---|---|---|---|---|---|---|
| 8810 | 195.3(MID) | 0.5LT | 3050 | 15.5 | 315 | 0.005057 | LA |

NOTE: BALL CENTERED FLIGHT



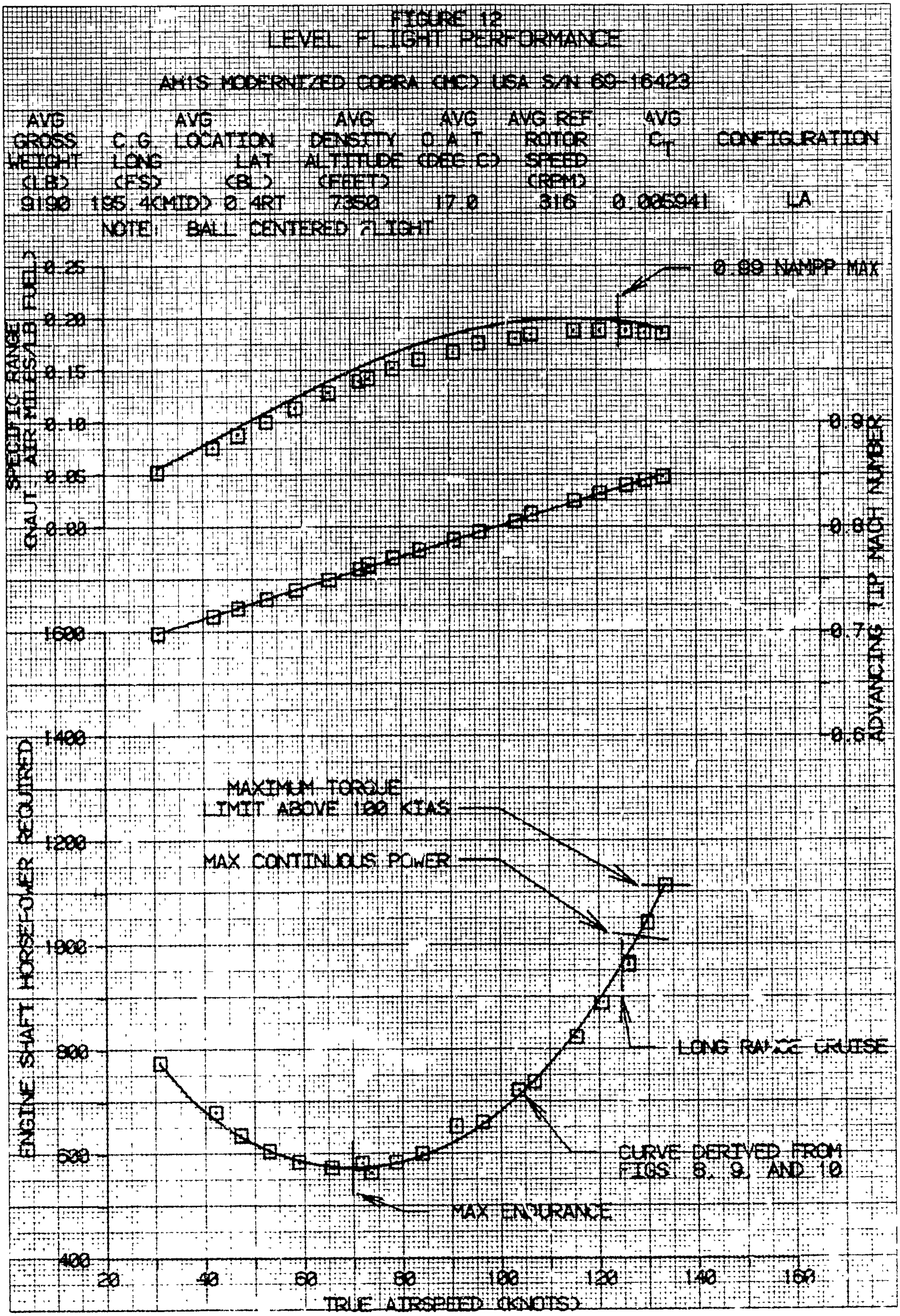



FIGURE 12
LEVEL FLIGHT PERFORMANCE

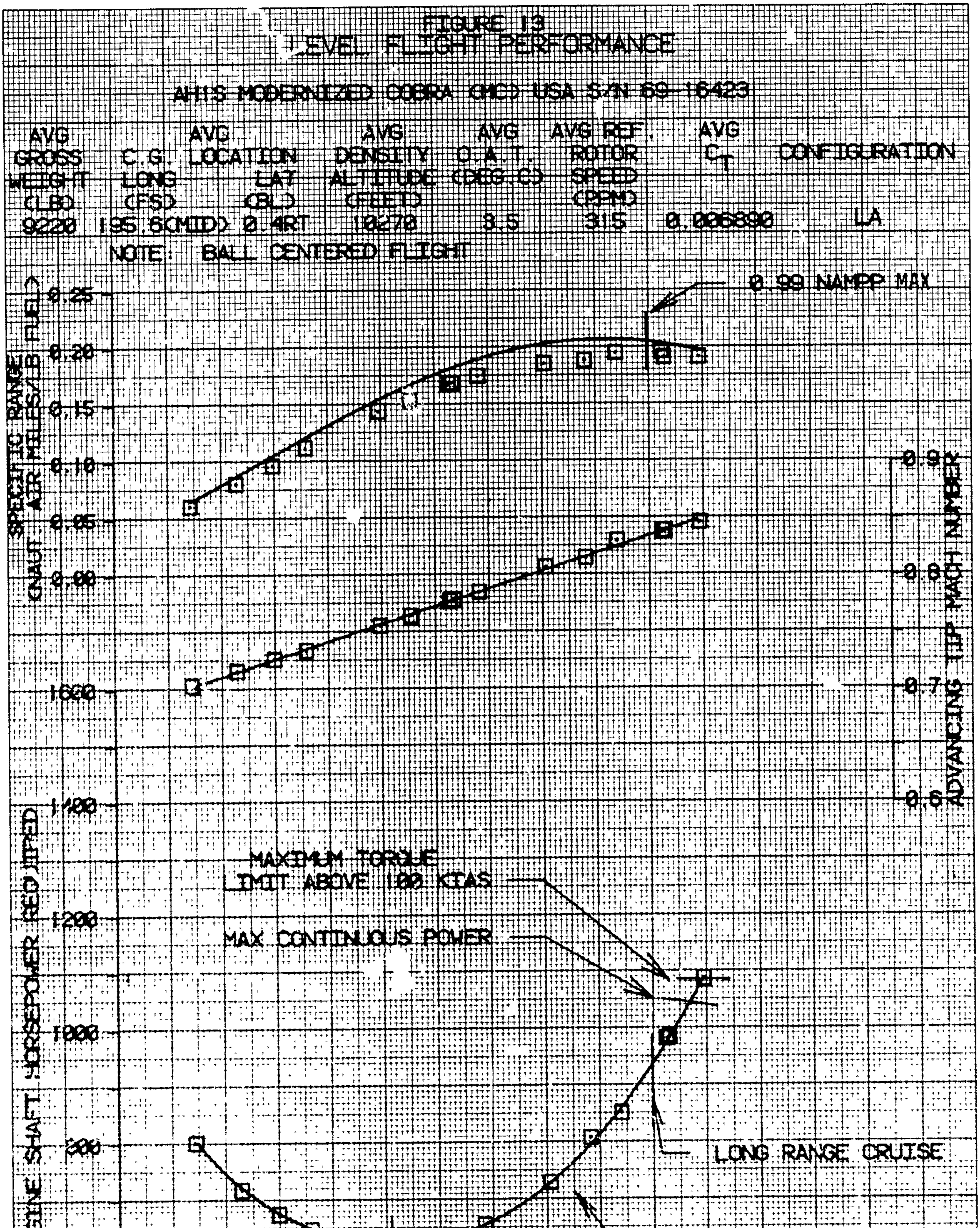


FIGURE 13
LEVEL FLIGHT PERFORMANCE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9220
AVG C.G. LOCATION LONG (FS) 195.6(MID)
LAT (BL) 0.4RT
AVG DENSITY ALTITUDE (FEET) 10270
AVG O.A.T. (DEG C) 3.5
AVG REF. ROTOR SPEED (RPM) 315
AVG $C_T$ 0.006890
CONFIGURATION LA
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
MAXIMUM TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 8, 9, AND 10
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

FIGURE 14
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.9 (MID)
5. AVG LAT. CG LOCATION BL 0.9 RT
6. CURVES DERIVED FROM FIGS. 17 - 19

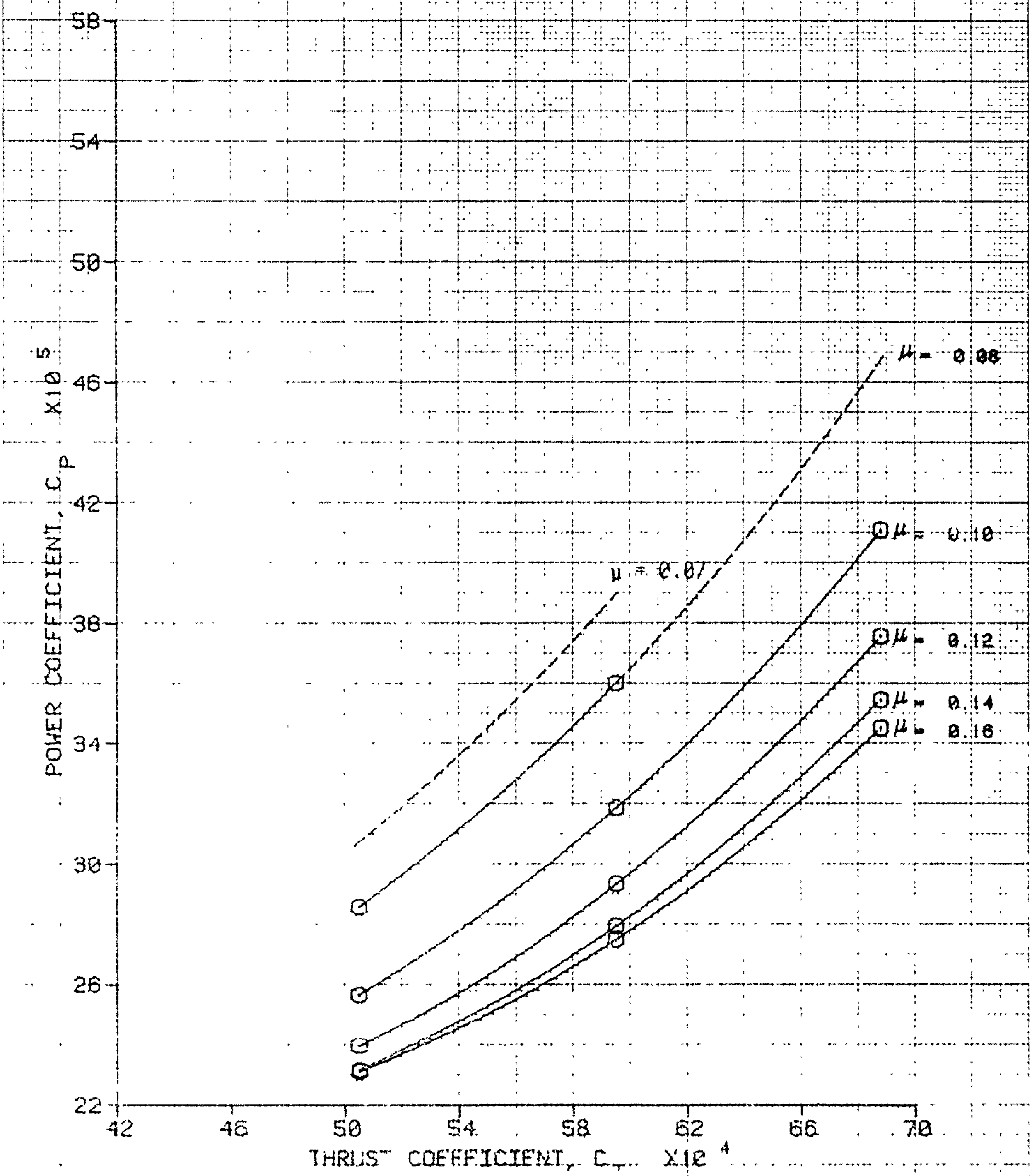
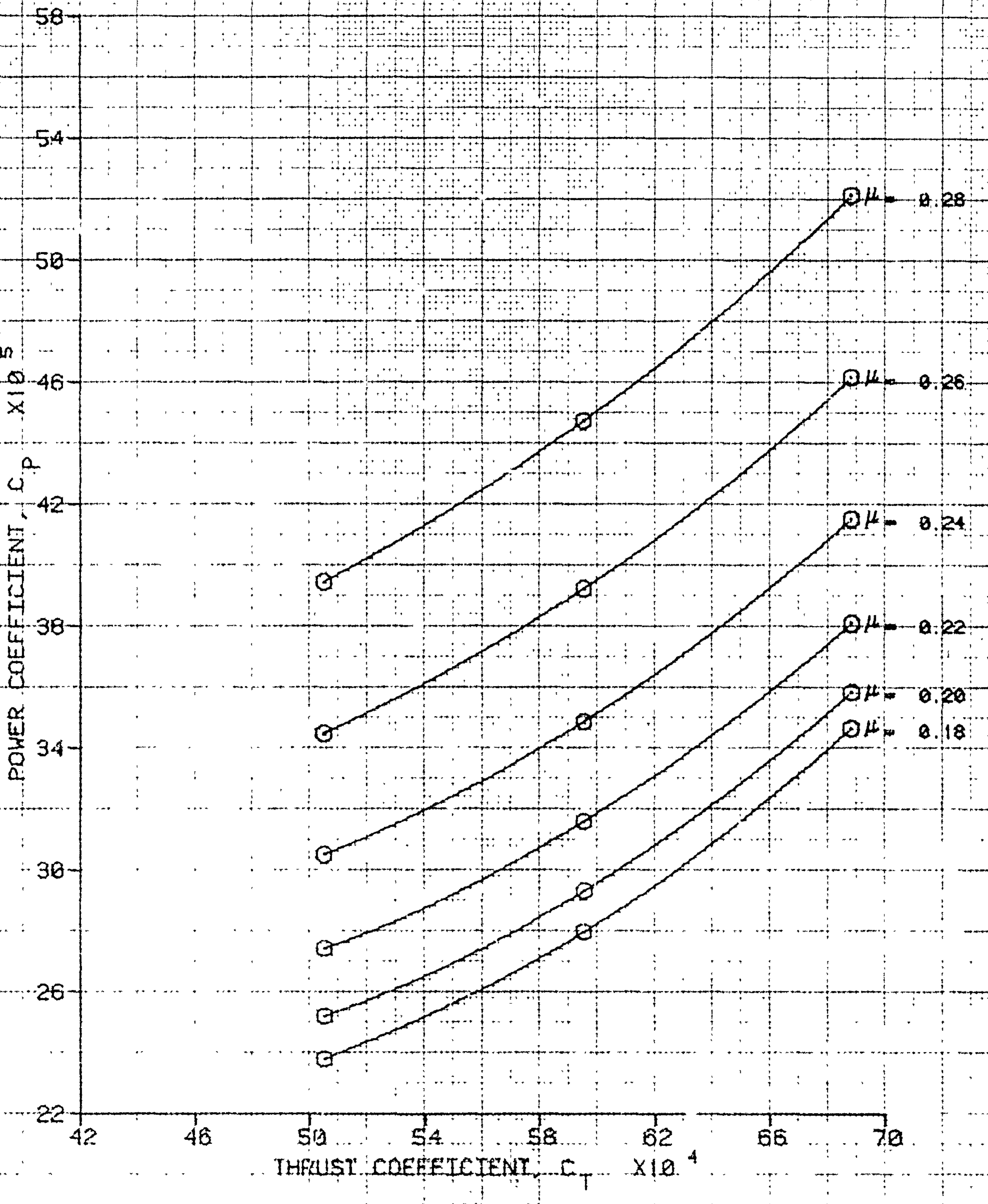


FIGURE 15
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES: 1. TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.9 (MID)
5. AVG LAT. CG LOCATION BL 0.9 RT
6. CURVES DERIVED FROM FIGS. 17 - 19



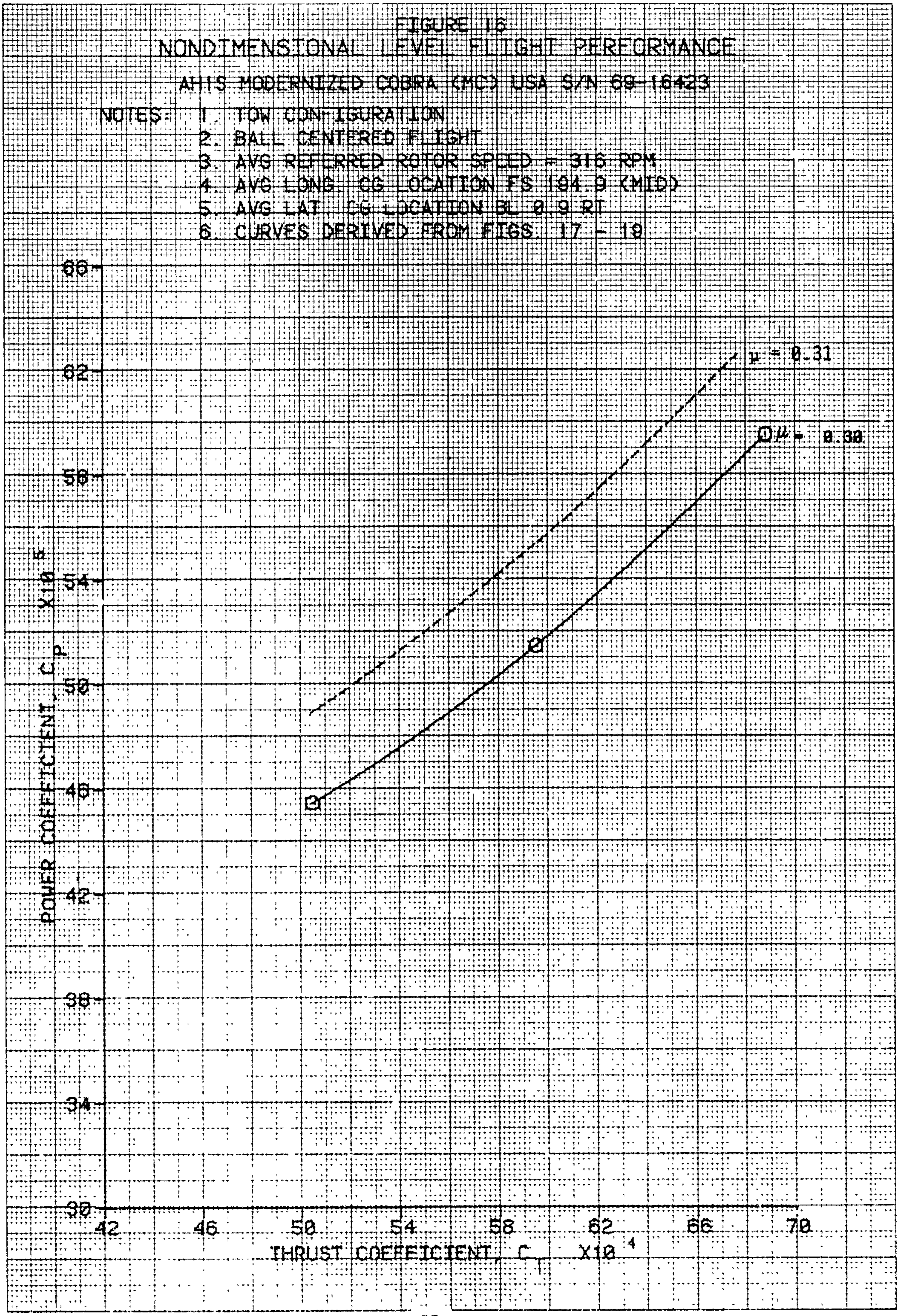


FIGURE 16
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
NOTES: 1. TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.9 (MID)
5. AVG LAT. CG LOCATION BL 0.9 RT
6. CURVES DERIVED FROM FIGS. 17 - 19
μ = 0.31
μ = 0.30
POWER COEFFICIENT, $C_P$ X10$^5$
THRUST COEFFICIENT, $C_T$ X10$^4$
66
62
58
54
50
46
42
38
34
30
42
46
50
54
58
62
66
70

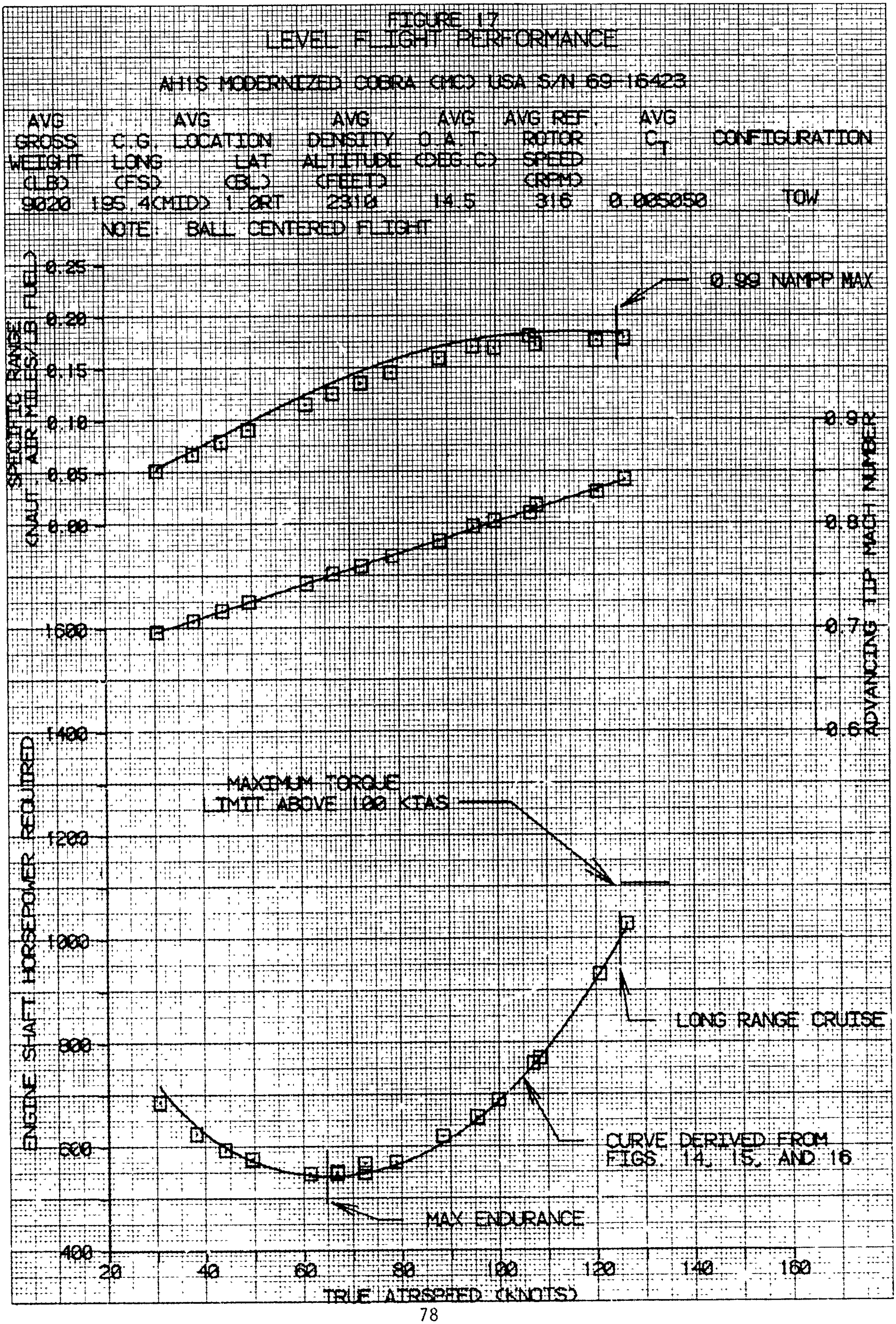


FIGURE 17
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9020
AVG C.G. LOCATION LONG (FS) 195.4(MID) LAT (BL) 1.0RT
AVG DENSITY ALTITUDE (FEET) 2310
AVG O.A.T. (DEG.C) 14.5
AVG REF. ROTOR SPEED (RPM) 316
AVG $C_T$ 0.005050
CONFIGURATION TOW
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
MAXIMUM TORQUE LIMIT ABOVE 100 KTAS
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 14, 15, AND 16
MAX ENDURANCE
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

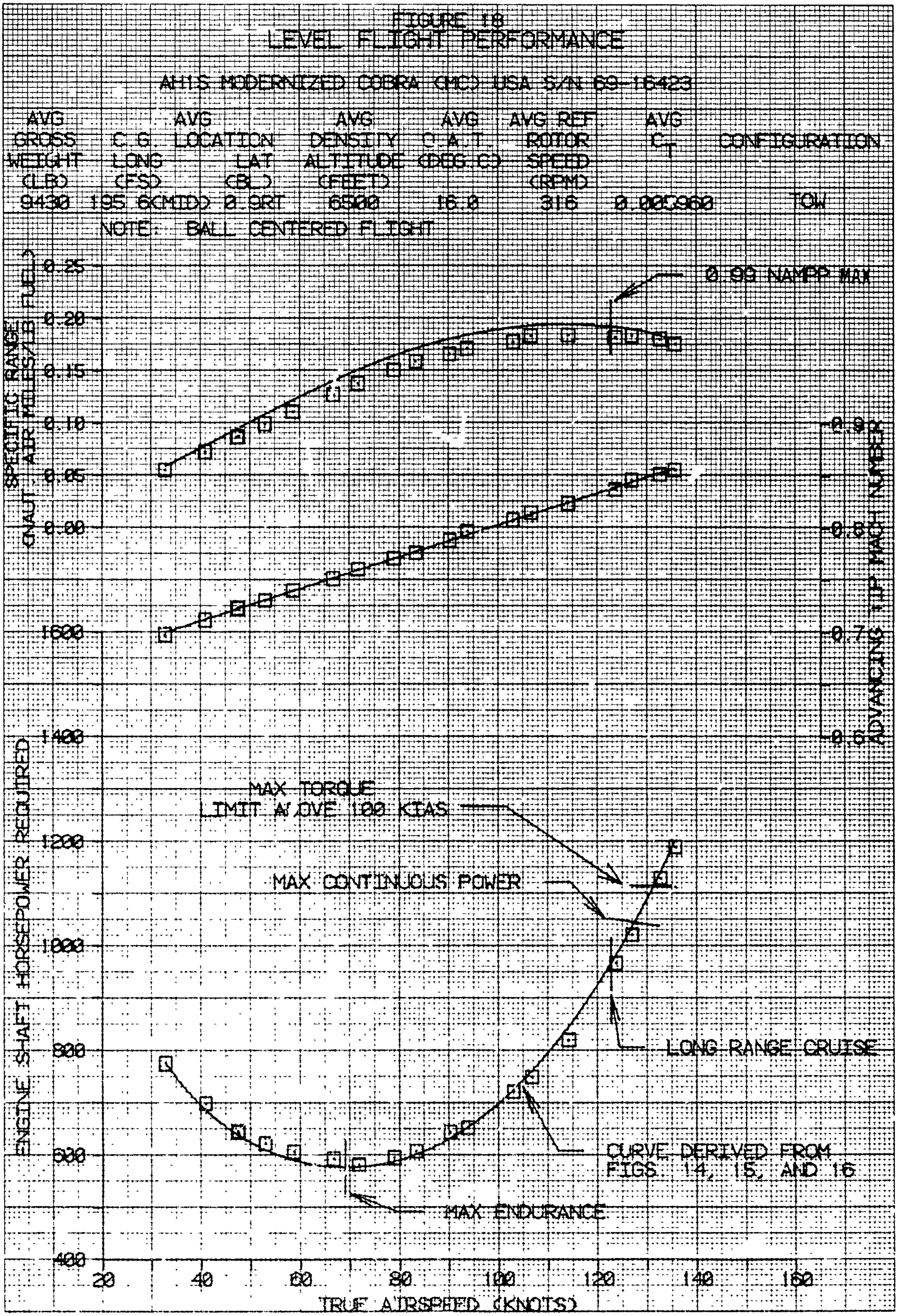


FIGURE 18
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9430
AVG C.G. LOCATION LONG (FS) 195.6(MID) LAT (BL) 0.9RT
AVG DENSITY ALTITUDE (FEET) 6500
AVG O.A.T. (DEG C) 16.0
AVG REF. ROTOR SPEED (RPM) 316
AVG $C_T$ 0.005960
CONFIGURATION TOW
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 14, 15, AND 16
MAX ENDURANCE
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

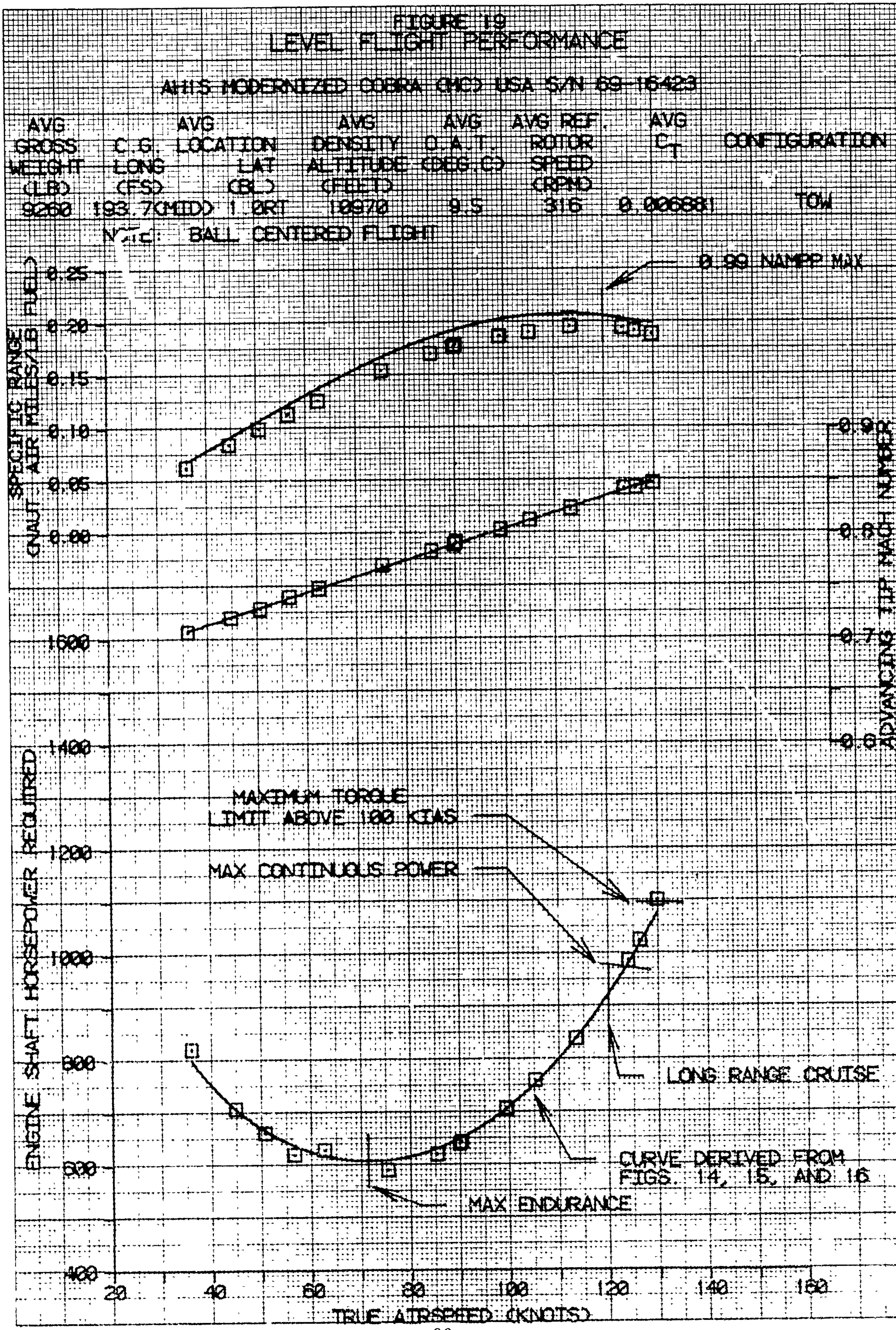


FIGURE 19
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9260
AVG C.G. LOCATION LONG (FS) 193.7(MID) LAT (BL) 1.0RT
AVG DENSITY ALTITUDE (FEET) 10970
AVG O.A.T. (DEG.C) 9.5
AVG REF. ROTOR SPEED (RPM) 316
AVG $C_T$ 0.006881
CONFIGURATION TOW
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
MAXIMUM TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 14, 15, AND 16
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

FIGURE 20

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.5 (MID)
5. AVG LAT. CG LOCATION BL 2.67 LT
6. CURVES DERIVED FROM FIGS. 23 - 25

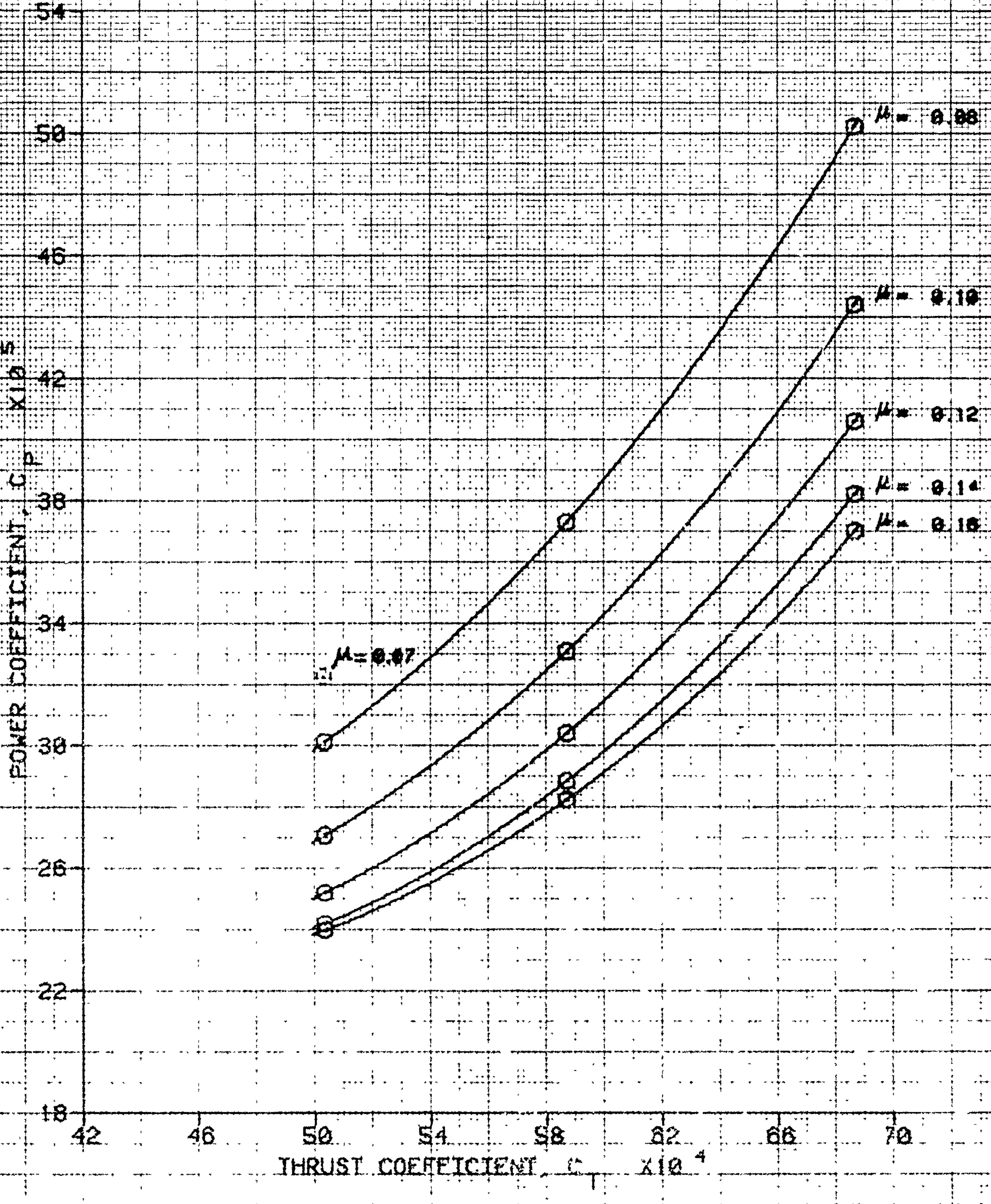


FIGURE 21
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.5 (MID)
5. AVG LAT. CG LOCATION BL 2.67 LT
6. CURVES DERIVED FROM FIGS. 23 - 25

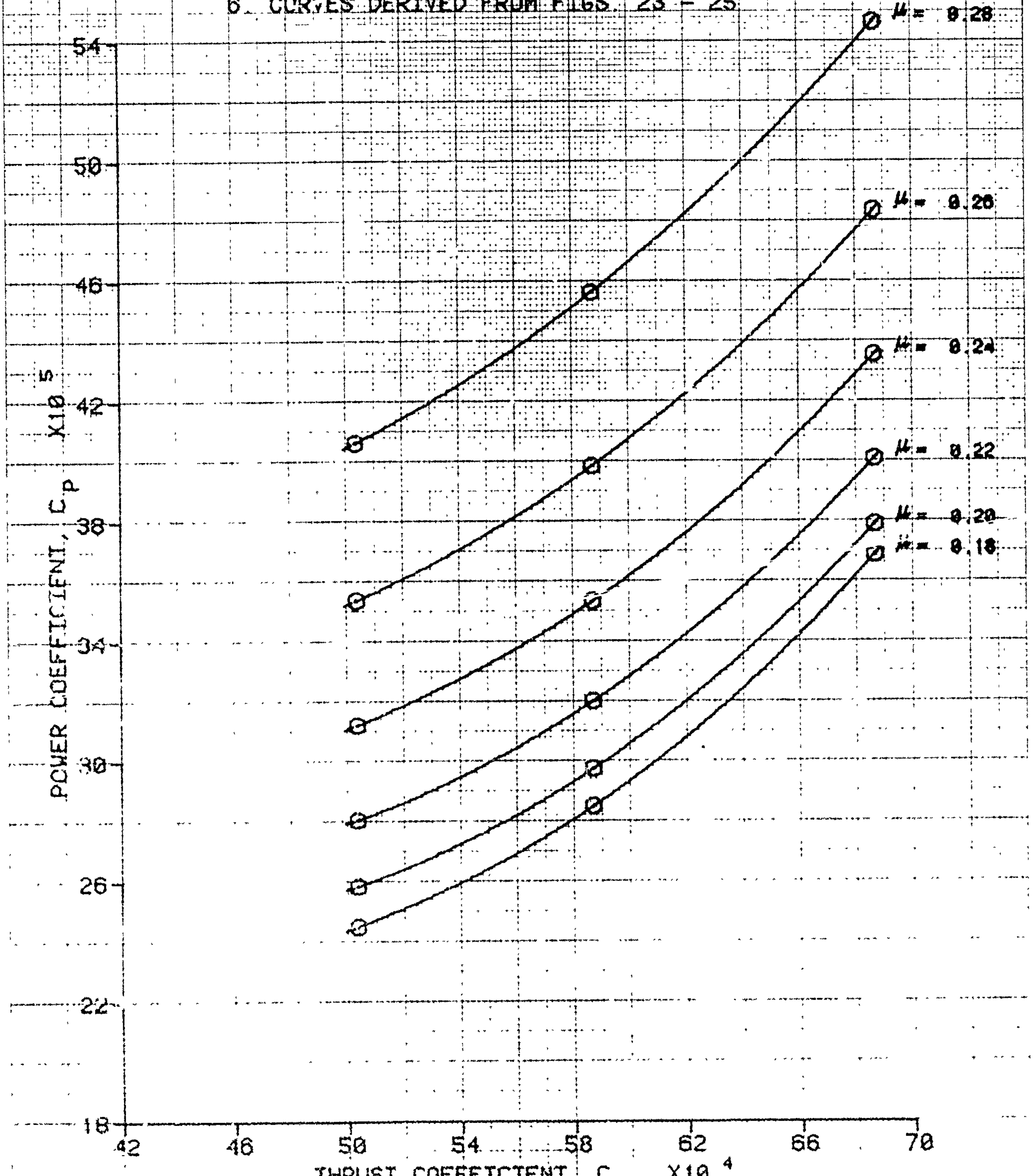
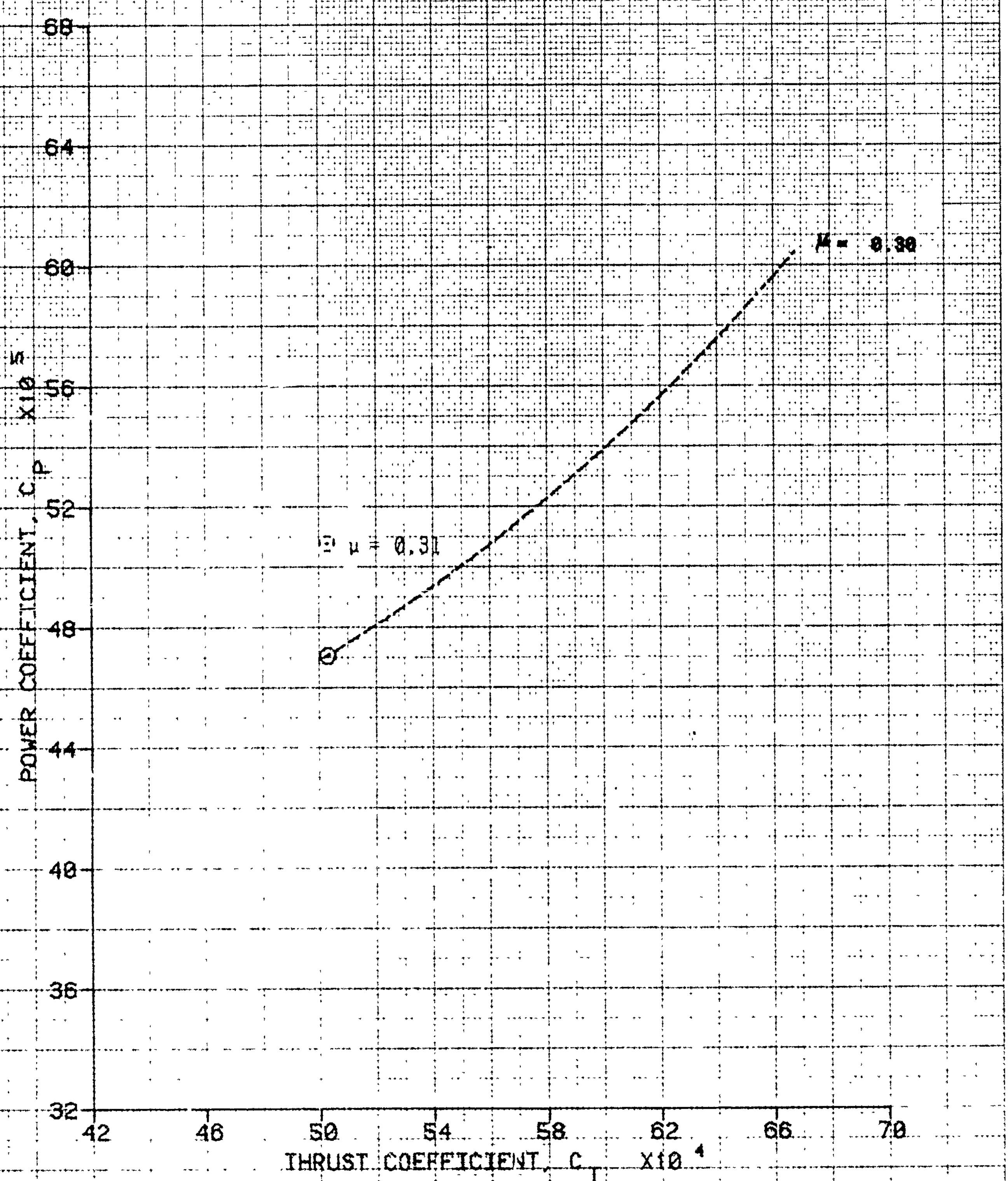


FIGURE 22

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.5 (MID)
5. AVG LAT. CG LOCATION BL 2.67 LT
6. CURVES DERIVED FROM FIGS. 23 - 25



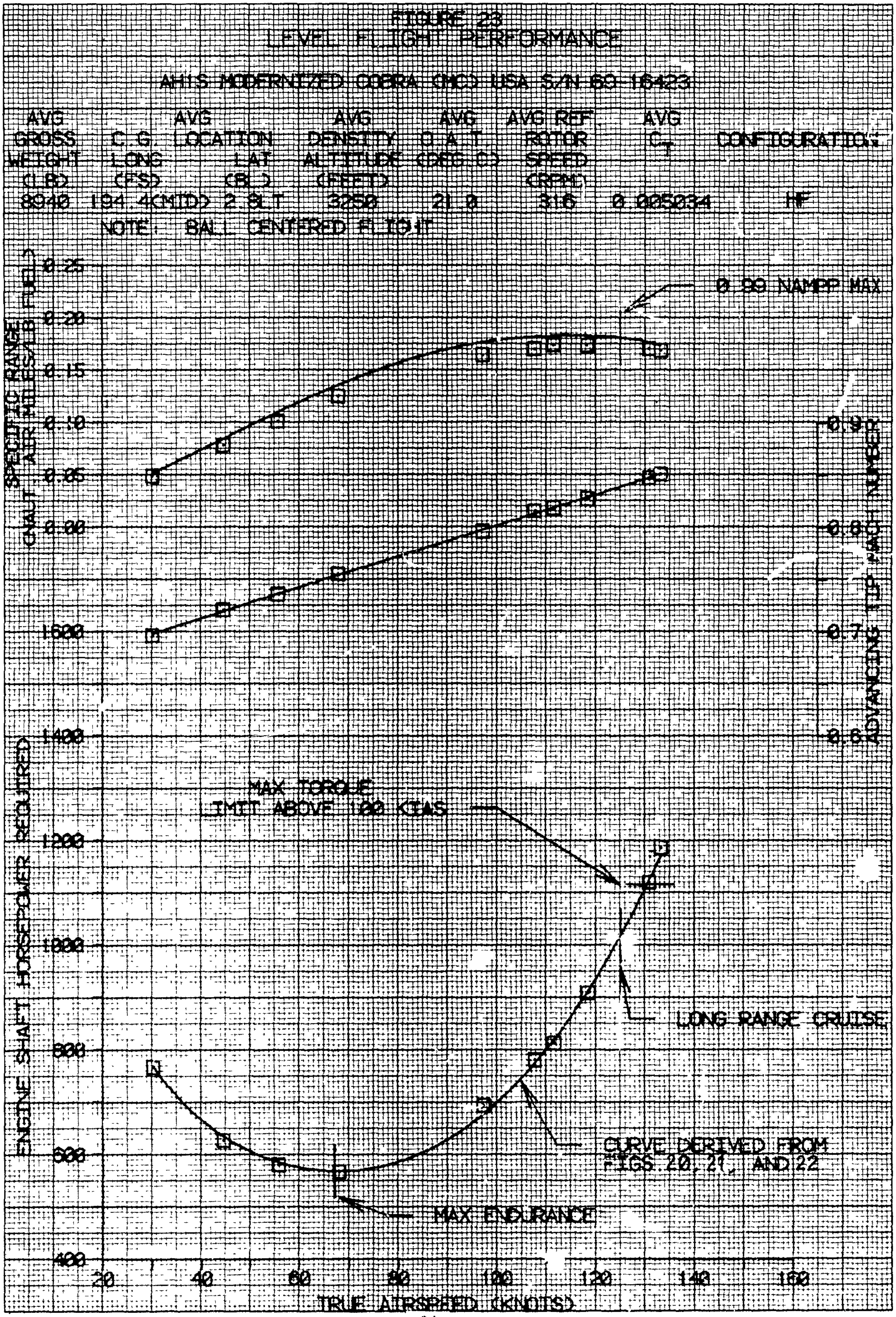


FIGURE 23
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB)
AVG C.G. LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FEET)
AVG O.A.T. (DEG C)
AVG REF. ROTOR SPEED (RPM)
AVG C_T
CONFIGURATION
8940 194.4(MID) 2.8LT 3250 21.0 316 0.005034 HF
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
0.90 NAMPP MAX
0.9
0.8
0.7
0.6
ADVANCING TIP MACH NUMBER
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
MAX TORQUE LIMIT ABOVE 100 KIAS
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS.20,21, AND 22
MAX ENDURANCE
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

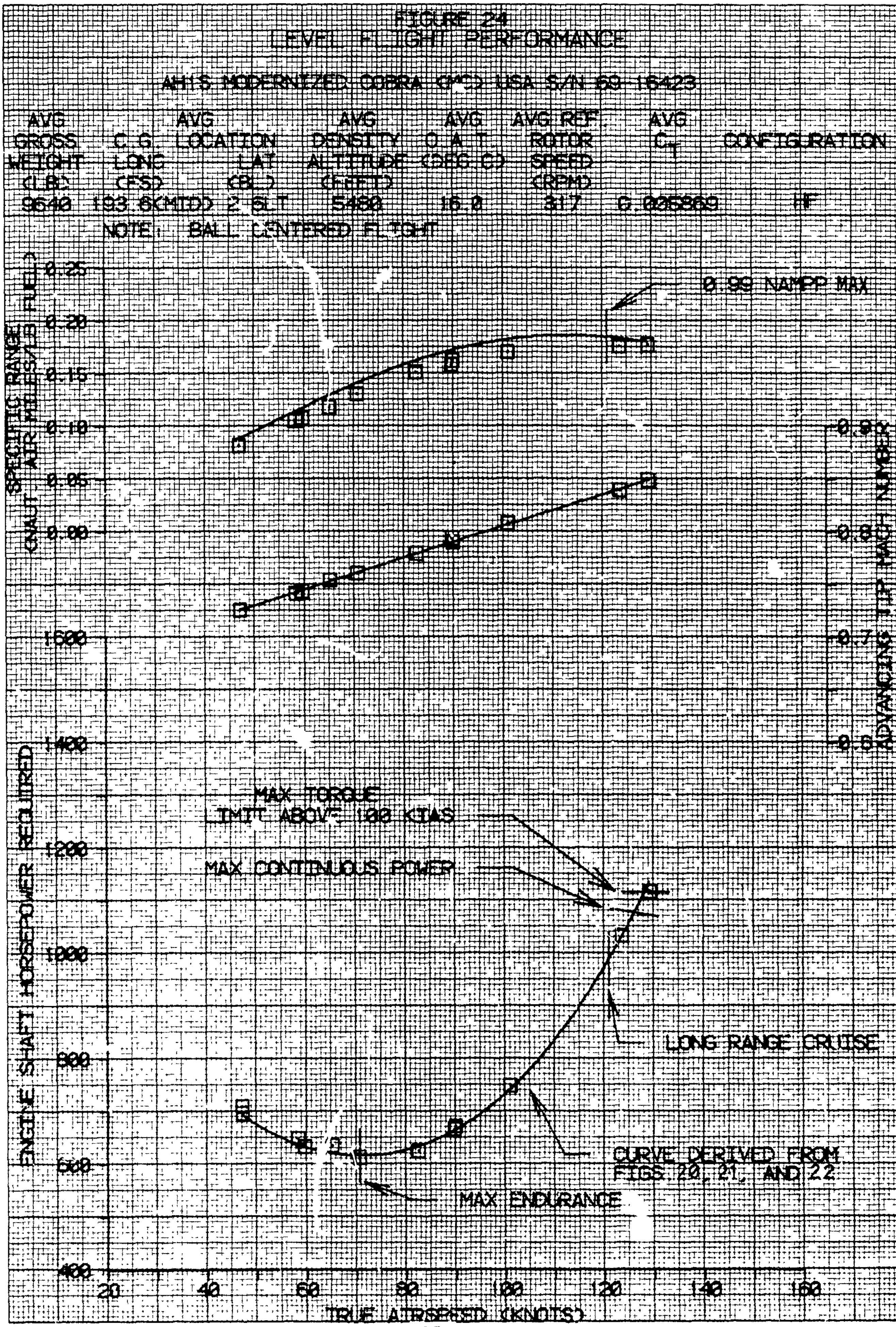


FIGURE 24
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB)
AVG C.G. LOCATION LONG (FS) LAT (BL)
AVG DENSITY ALTITUDE (FEET)
AVG O.A.T. (DEG C)
AVG REF. ROTOR SPEED (RPM)
AVG $C_T$
CONFIGURATION
9640 193.6(MID) 2.6LT 5480 16.0 317 0.005869 HF
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS 20, 21, AND 22
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

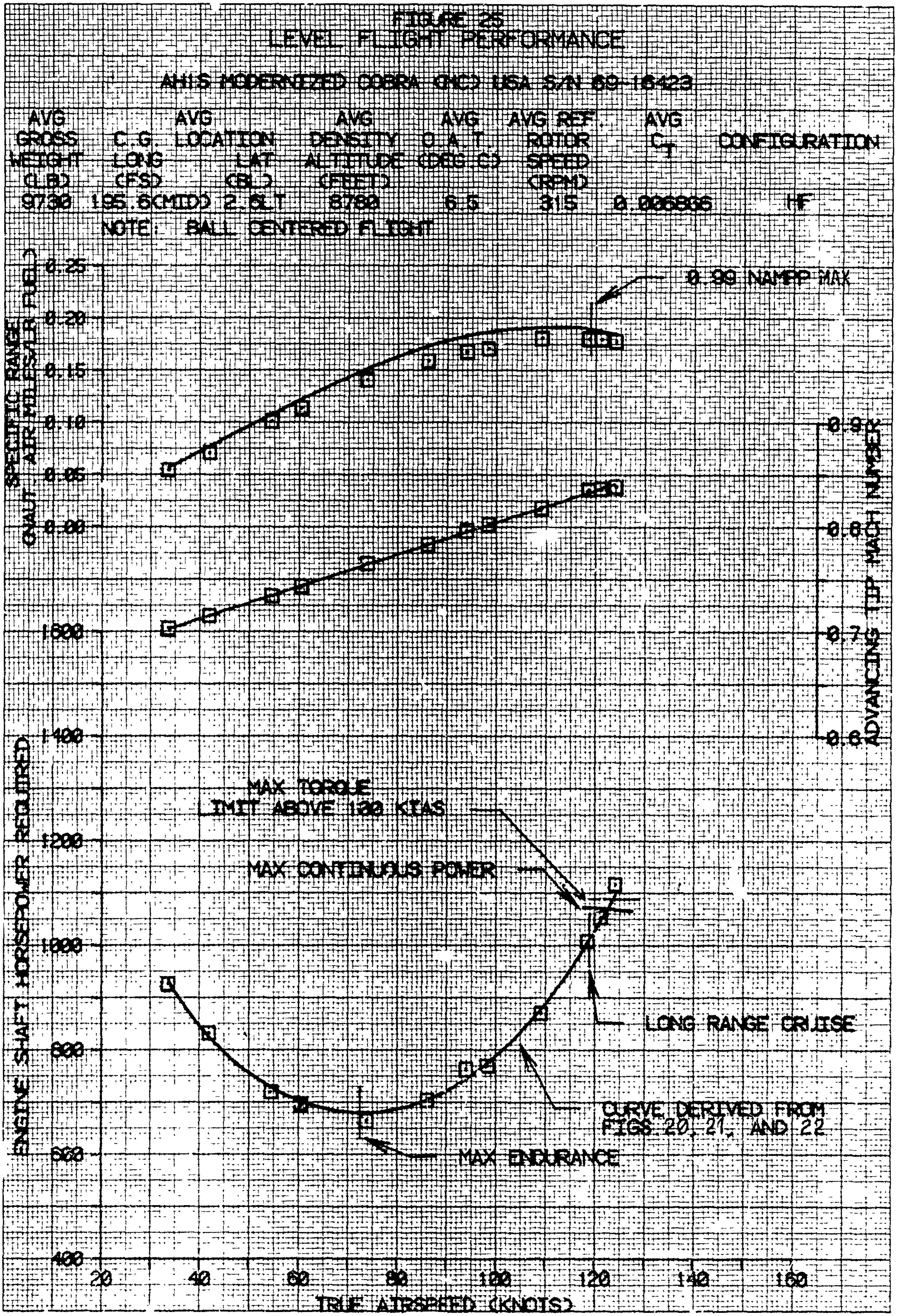


FIGURE 25
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9730
AVG C.G. LOCATION LONG (FS) 195.6(MID) LAT (BL) 2.6LT
AVG DENSITY ALTITUDE (FEET) 8780
AVG O.A.T. (DEG C) 6.5
AVG REF. ROTOR SPEED (RPM) 315
AVG $C_T$ 0.006896
CONFIGURATION HF
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
MAX TORQUE LIMIT ABOVE 130 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS 20, 21, AND 22
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

FIGURE 26

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.0 (MID)
5. AVG LAT. CG LOCATION BL 1.7 LT
6. CURVES DERIVED FROM FIGS. 29 - 31

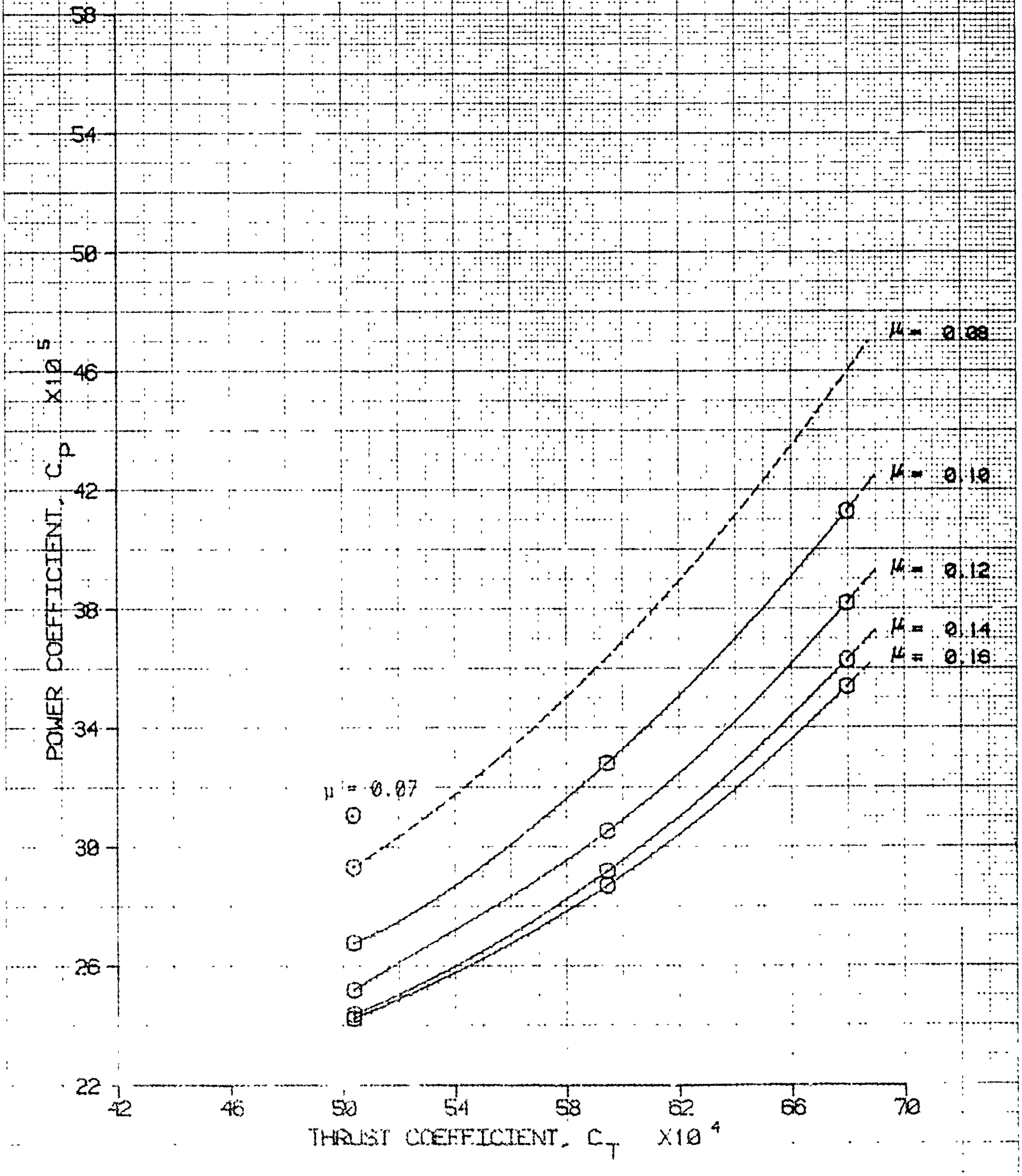


FIGURE 27

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.0 (MID)
5. AVG LAT. CG LOCATION BL 1.7 LT
6. CURVES DERIVED FROM FIGS. 29 - 31

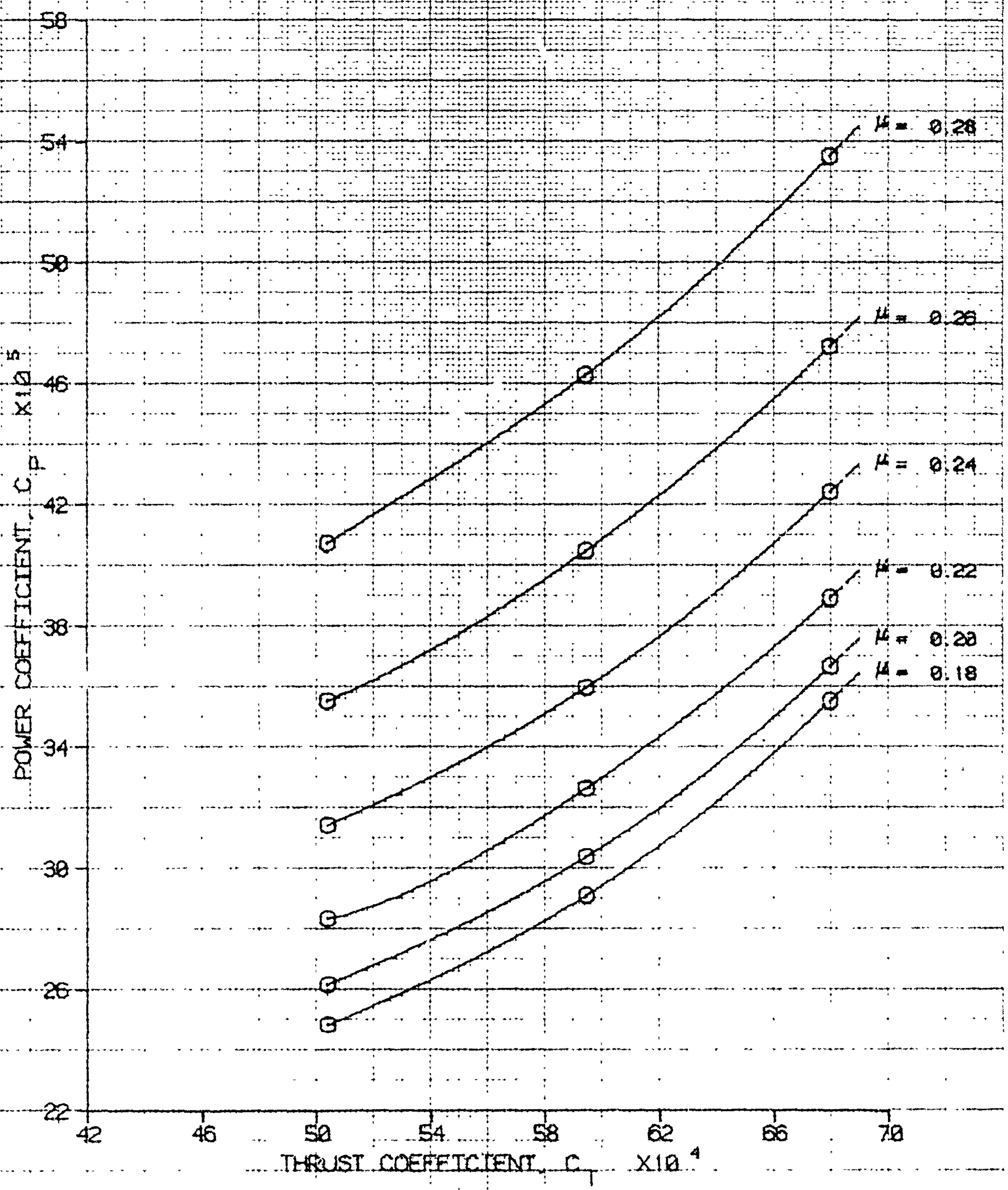
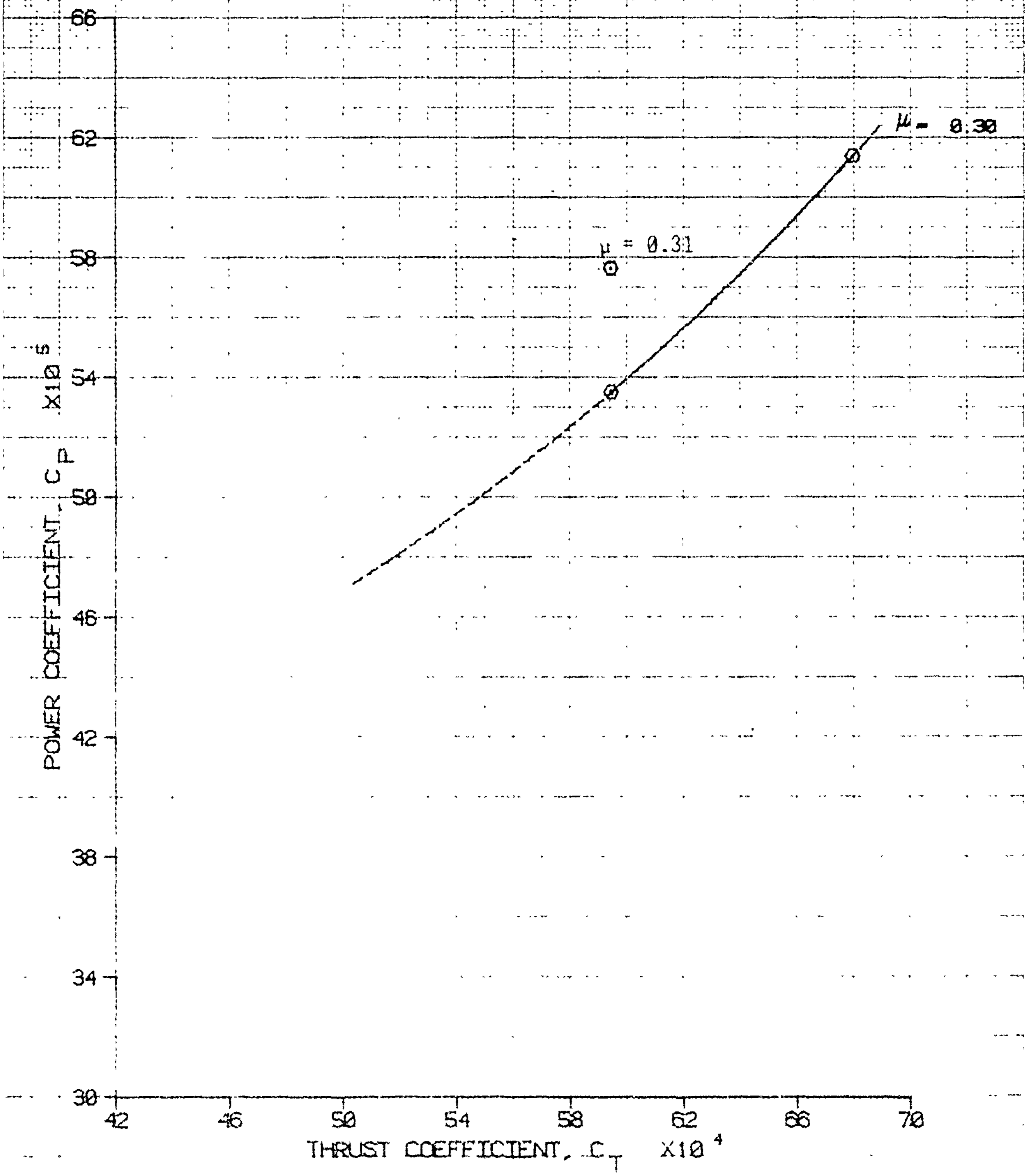


FIGURE 28

NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 195.0 (MID)
5. AVG LAT. CG LOCATION BL 1.7 LT
6. CURVES DERIVED FROM FIGS. 29 - 31



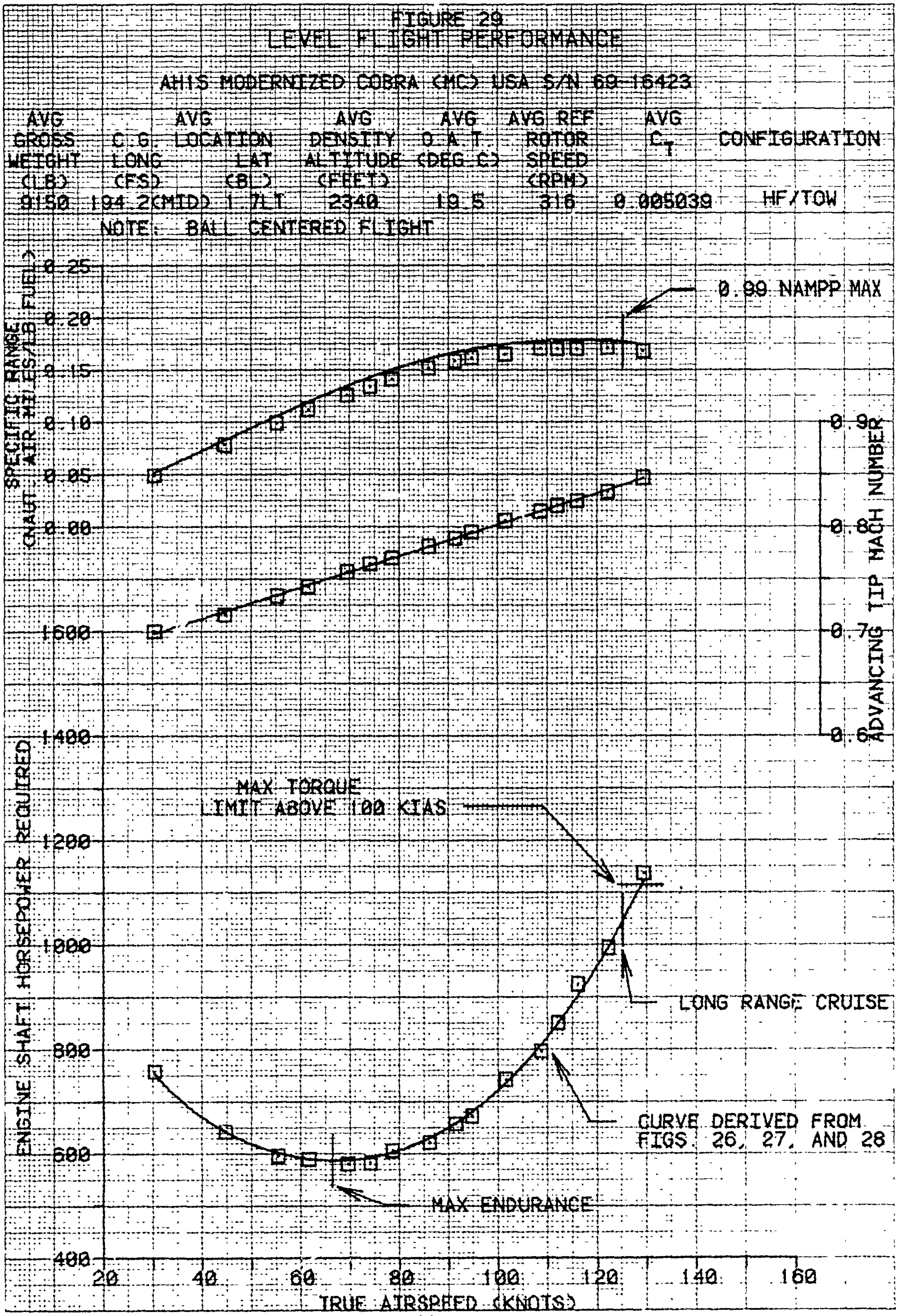


FIGURE 29
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9150
AVG C.G. LOCATION LONG (FS) 194.2(MID) LAT (BL) 1.7LT
AVG DENSITY ALTITUDE (FEET) 2340
AVG O.A.T. (DEG C) 19.5
AVG REF ROTOR SPEED (RPM) 316
AVG $C_T$ 0.005039
CONFIGURATION HF/TOW
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
MAX TORQUE LIMIT ABOVE 100 KIAS
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 26, 27, AND 28
MAX ENDURANCE
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

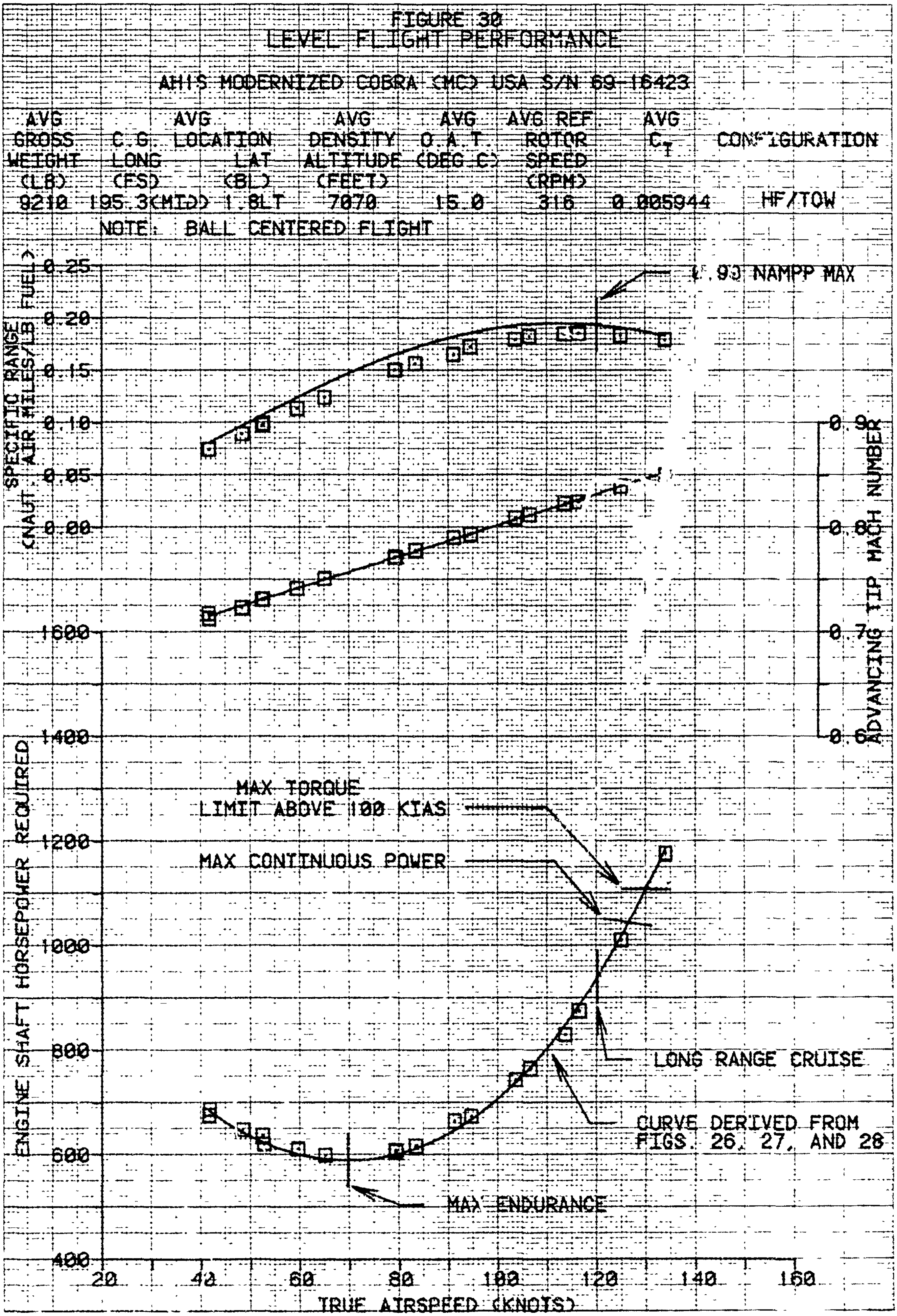



FIGURE 30
LEVEL FLIGHT PERFORMANCE

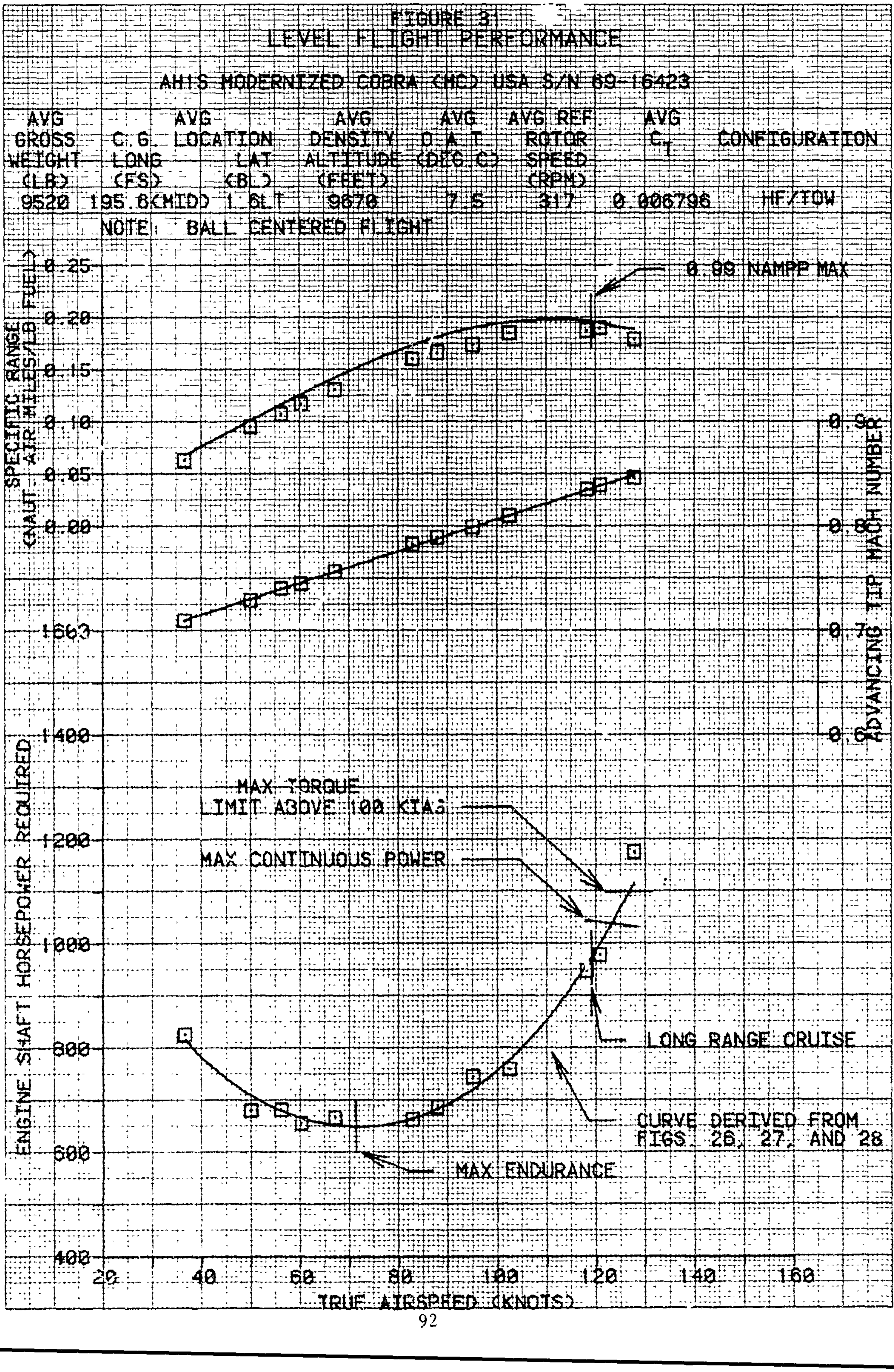


FIGURE 31
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9520
AVG C.G. LOCATION LONG (FS) 195.6(MID) LAT (BL) 1.6LT
AVG DENSITY ALTITUDE (FEET) 9670
AVG O.A.T. (DEG C) 7.5
AVG REF. ROTOR SPEED (RPM) 317
AVG C_T 0.006796
CONFIGURATION HF/TOW
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
ADVANCING TIP MACH NUMBER
MAX TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 26, 27, AND 28
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
TRUE AIRSPEED (KNOTS)

FIGURE 32
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.7 (MID)
5. AVG LAT. CG LOCATION BL 1.6 LT
6. CURVES DERIVED FROM FIGS. 35 - 37

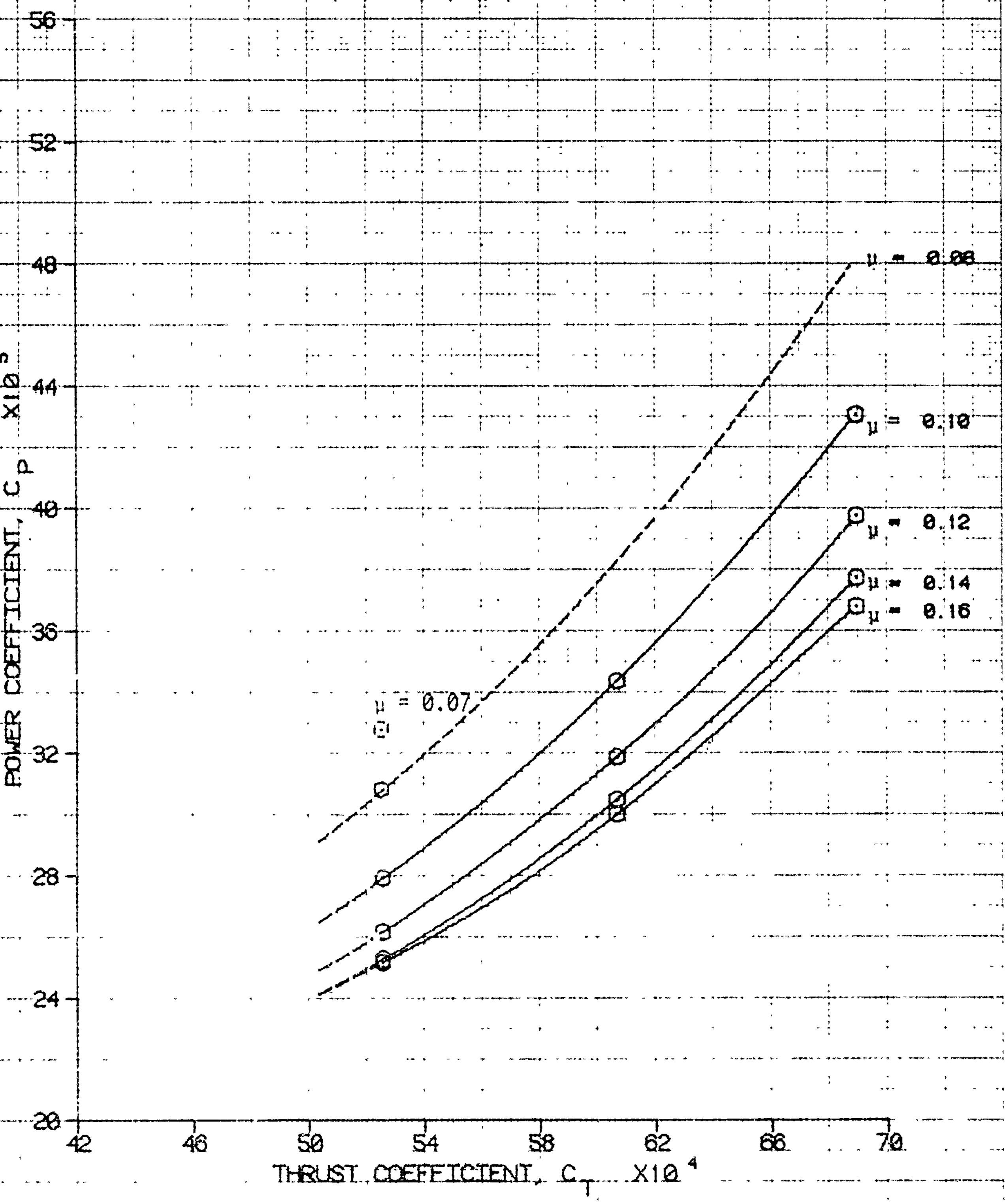


FIGURE 33
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

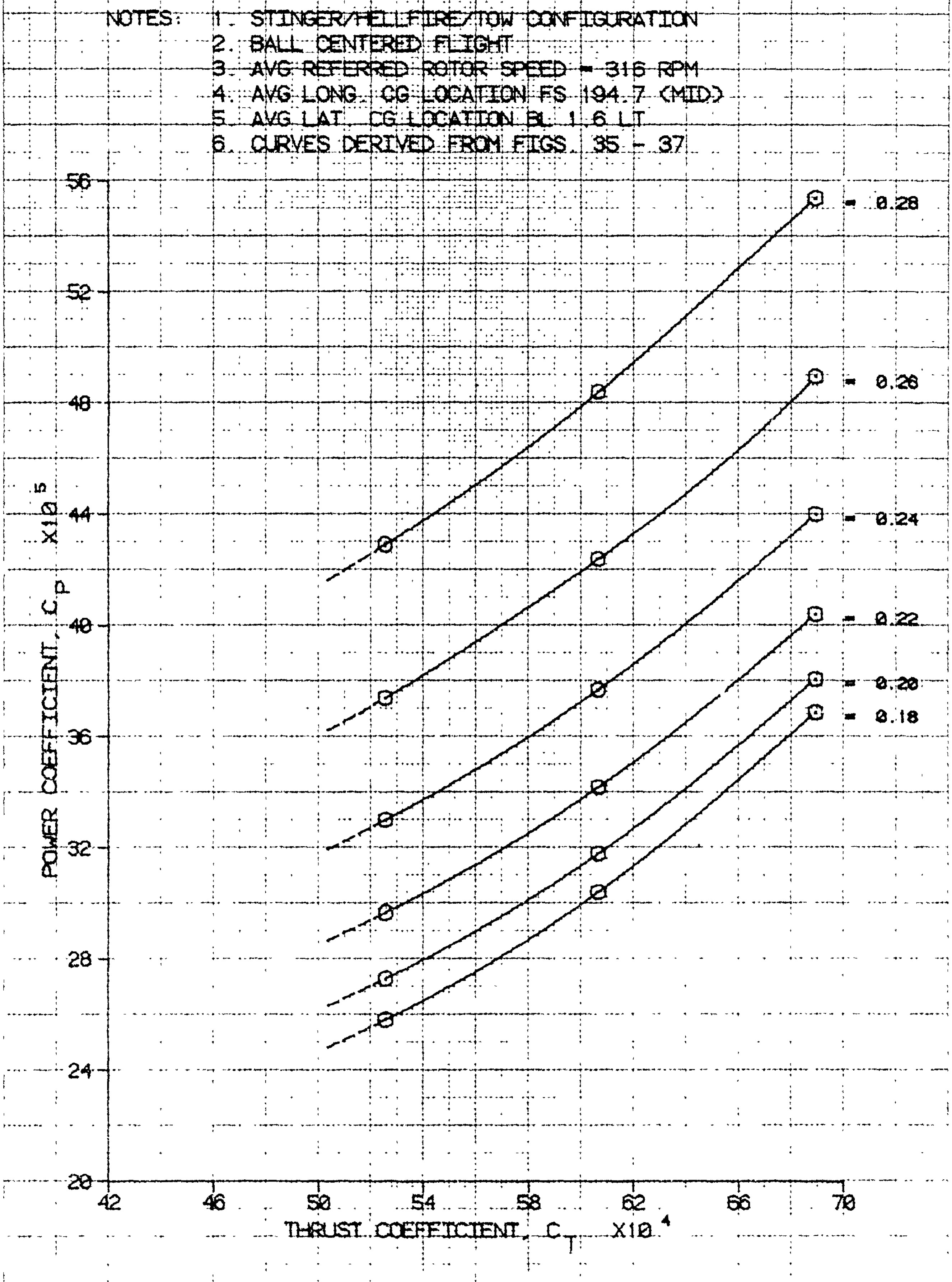
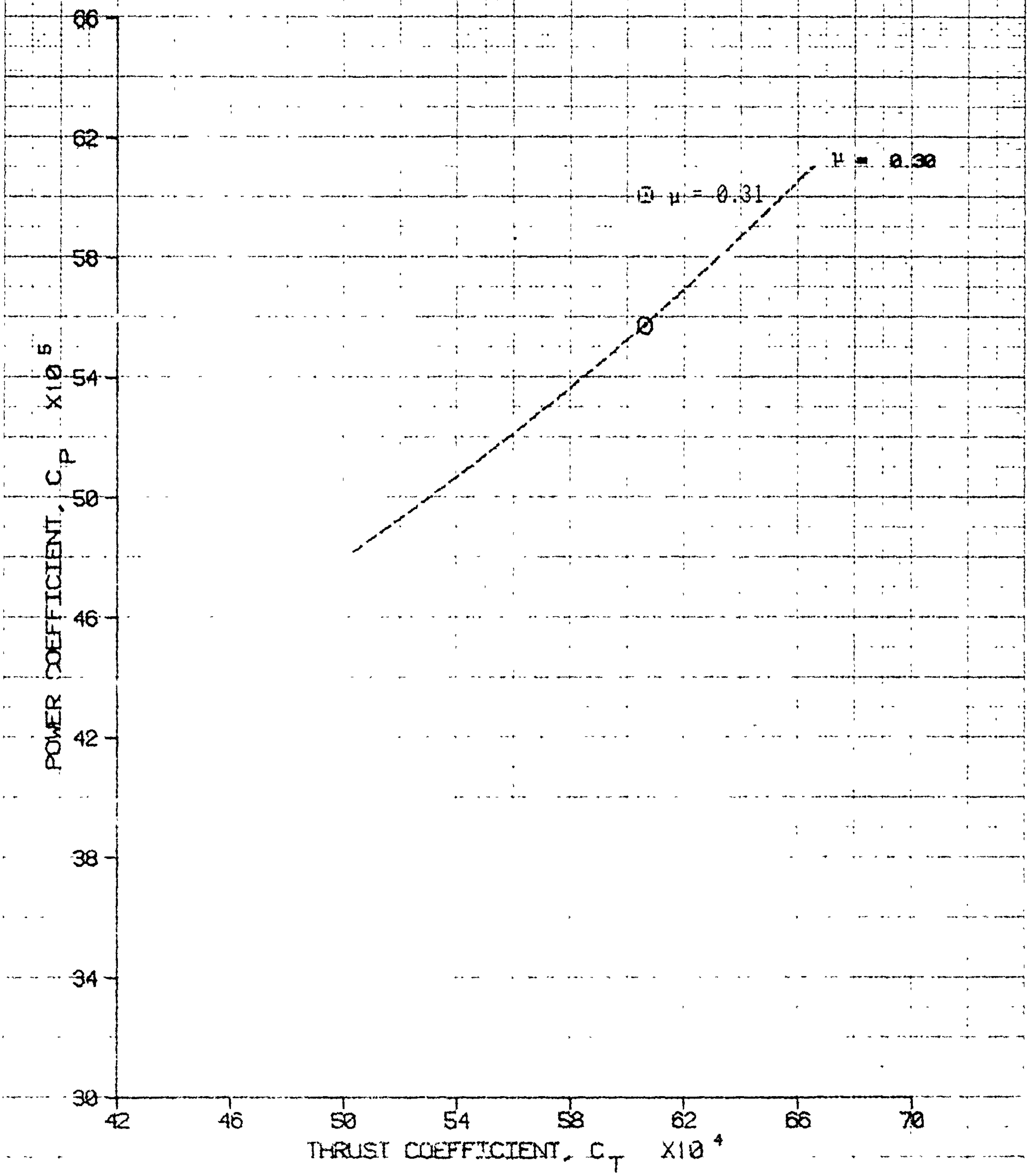


FIGURE 34
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES:
1. STINGER/HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. AVG REFERRED ROTOR SPEED = 316 RPM
4. AVG LONG. CG LOCATION FS 194.7 (MID)
5. AVG LAT. CG LOCATION BL 1.6 LT
6. CURVES DERIVED FROM FIGS. 35 - 37



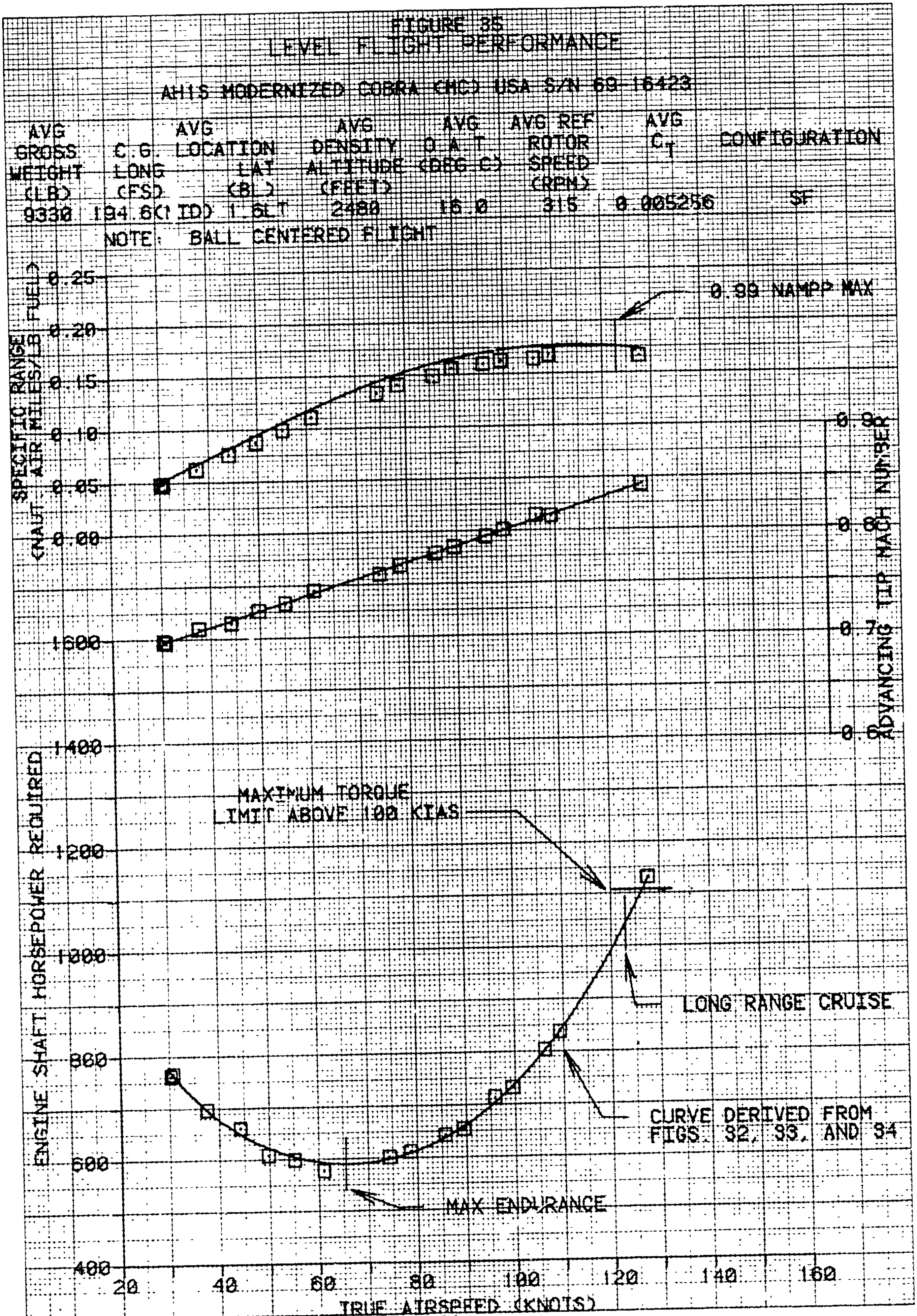


FIGURE 35
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9330
AVG C.G. LOCATION LONG (FS) 194.6(MID) LAT (BL) 1.6LT
AVG DENSITY ALTITUDE (FEET) 2480
AVG O.A.T. (DEG C) 16.0
AVG REF ROTOR SPEED (RPM) 315
AVG $C_T$ 0.005256
CONFIGURATION SF
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
MAXIMUM TORQUE LIMIT ABOVE 100 KIAS
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 32, 33, AND 34
MAX ENDURANCE
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

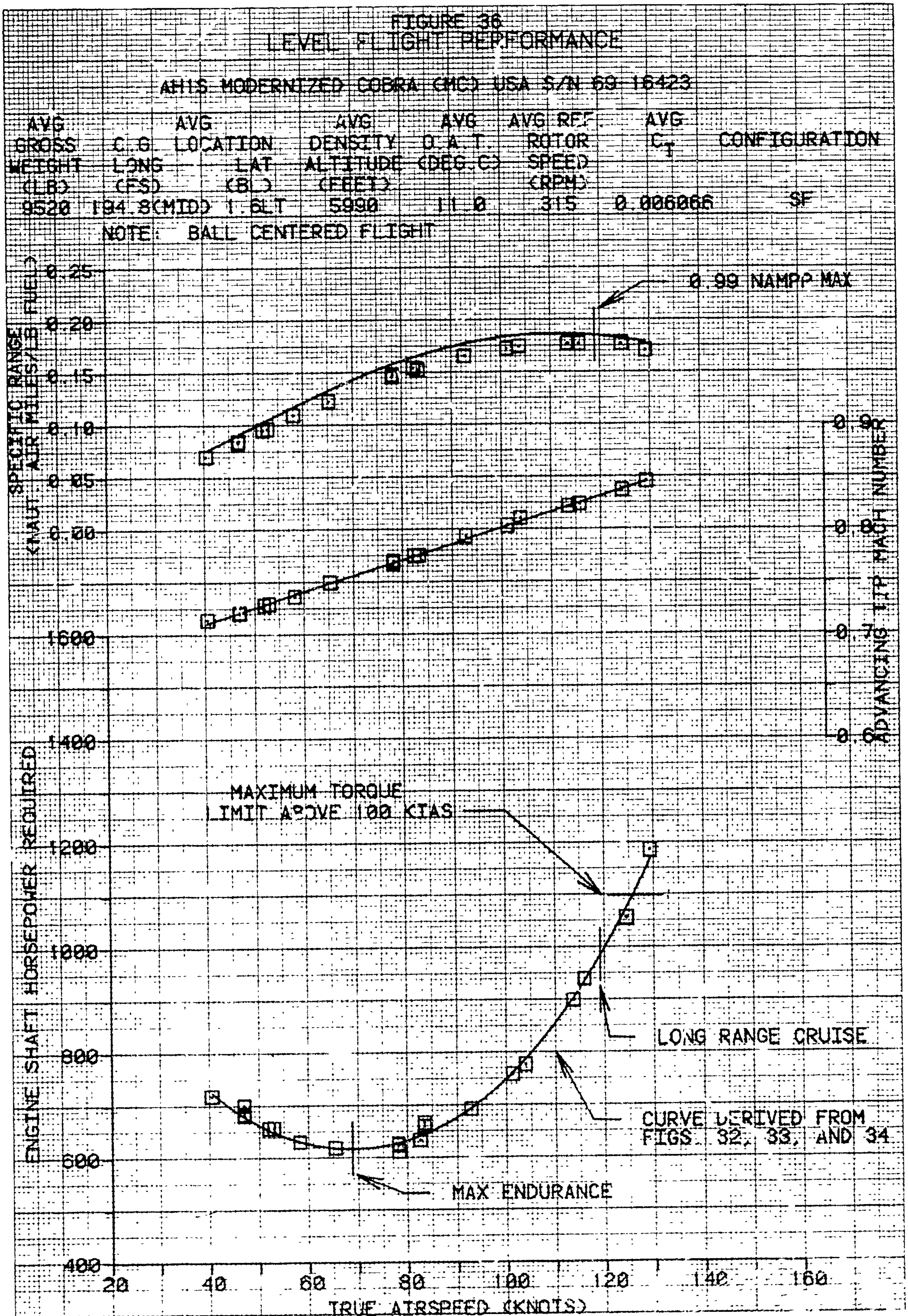


FIGURE 36
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9520
AVG C.G. LOCATION LONG (FS) 194.8(MID) LAT (BL) 1.6LT
AVG DENSITY ALTITUDE (FEET) 5990
AVG O.A.T. (DEG.C) 11.0
AVG REF. ROTOR SPEED (RPM) 315
AVG $C_T$ 0.006066
CONFIGURATION SF
NOTE: BALL CENTERED FLIGHT
SPECIFIC RANGE (NAUT. AIR MILES/LB FUEL)
0.99 NAMPP MAX
ADVANCING TIP MACH NUMBER
ENGINE SHAFT HORSEPOWER REQUIRED
MAXIMUM TORQUE LIMIT ABOVE 100 KIAS
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 32, 33, AND 34
MAX ENDURANCE
TRUE AIRSPEED (KNOTS)

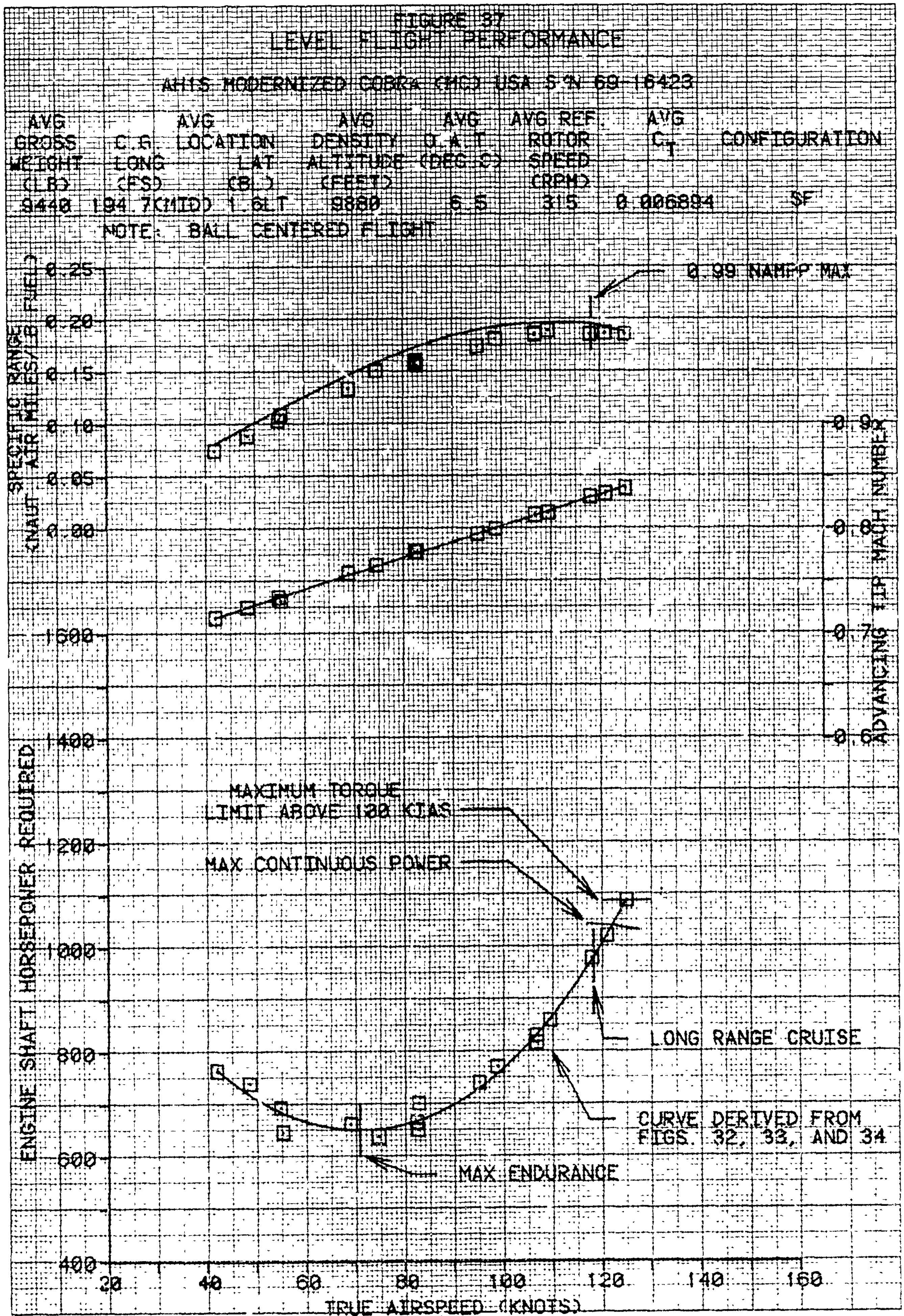


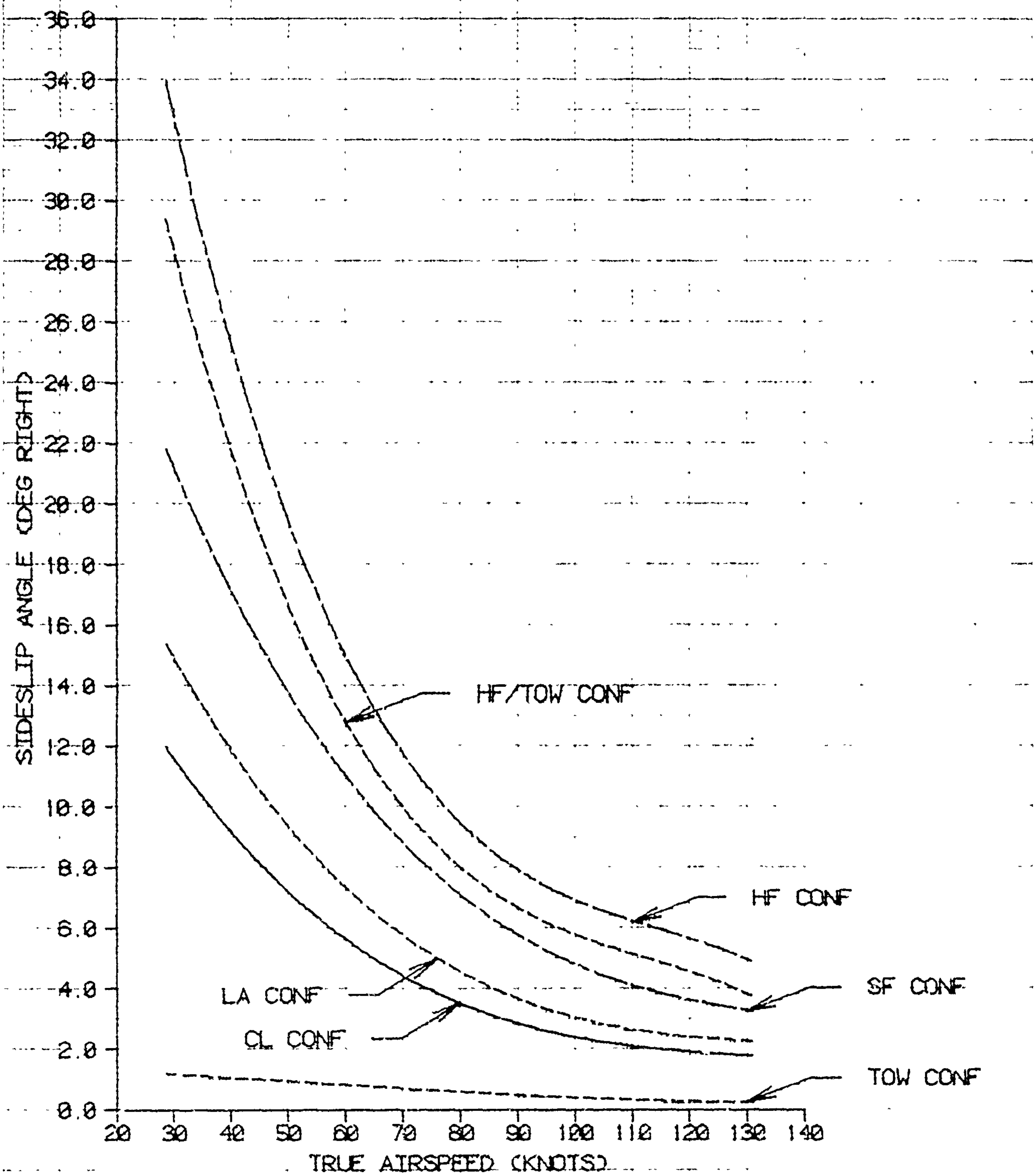
FIGURE 37
LEVEL FLIGHT PERFORMANCE
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9440
AVG C.G. LOCATION LONG (FS) 194.7(MID)
LAT (BL) 1.6LT
AVG DENSITY ALTITUDE (FEET) 9880
AVG O.A.T. (DEG C) 6.5
AVG REF. ROTOR SPEED (RPM) 315
AVG $C_T$ 0.006894
CONFIGURATION SF
NOTE: BALL CENTERED FLIGHT
0.99 NAMPP MAX
SPECIFIC RANGE (NAUT AIR MILES/LB FUEL)
0.25
0.20
0.15
0.10
0.05
0.00
ADVANCING TIP MACH NUMBER
0.9
0.8
0.7
0.6
MAXIMUM TORQUE LIMIT ABOVE 100 KIAS
MAX CONTINUOUS POWER
LONG RANGE CRUISE
CURVE DERIVED FROM FIGS. 32, 33, AND 34
MAX ENDURANCE
ENGINE SHAFT HORSEPOWER REQUIRED
1600
1400
1200
1000
800
600
400
20
40
60
80
100
120
140
160
TRUE AIRSPEED (KNOTS)

FIGURE 38

INHERENT SIDESLIP ANGLE

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

NOTES: 1. BALL CENTERED FLIGHT
2. AVG REFERRED ROTOR SPEED = 316 RPM
3. AVG LONG. CG LOCATION FS 195.4 (MID)



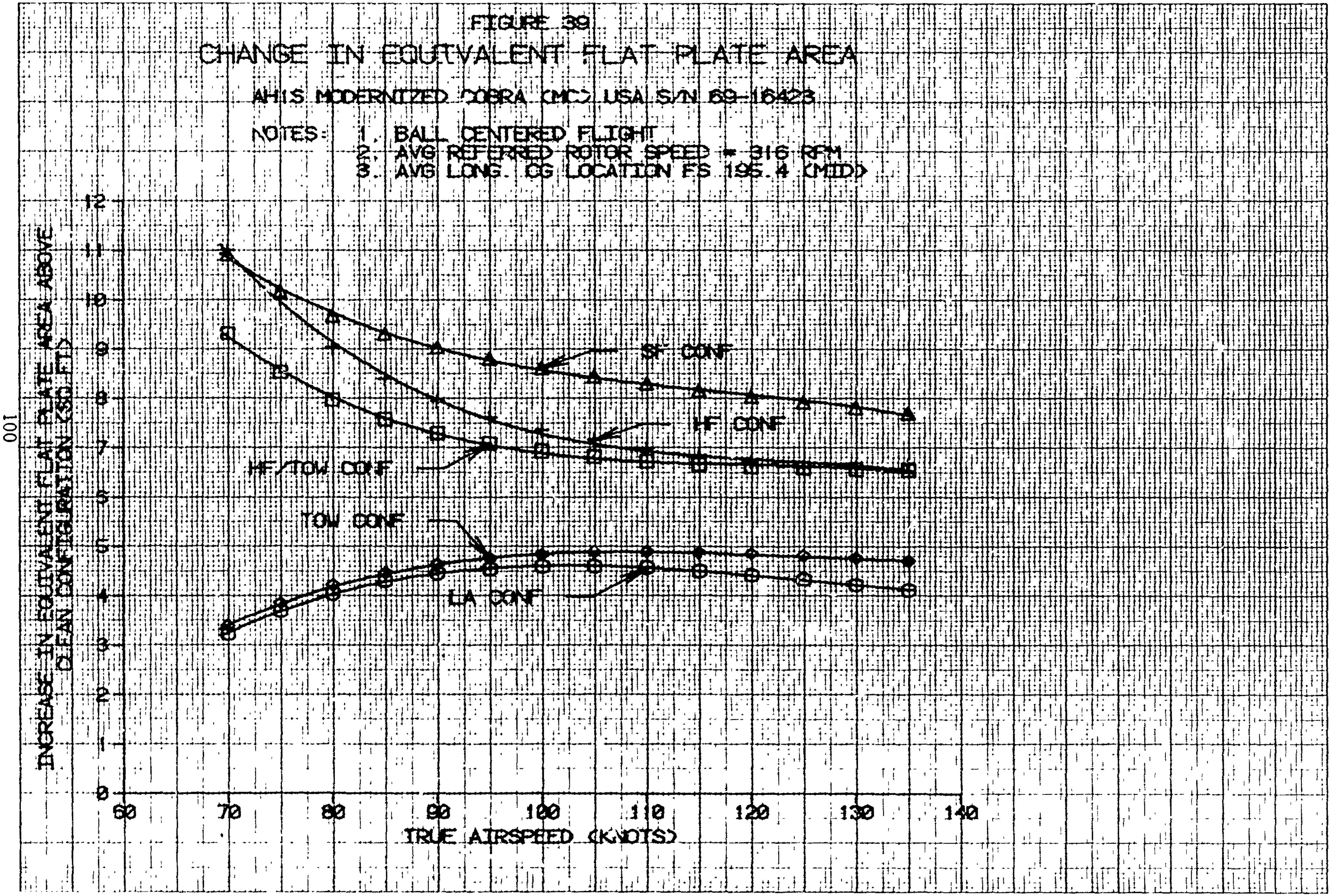


FIGURE 39
CHANGE IN EQUIVALENT FLAT PLATE AREA
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
NOTES: 1. BALL CENTERED FLIGHT
2. AVG REFERRED ROTOR SPEED = 316 RPM
3. AVG LONG. CG LOCATION FS 195.4 (MID)
SF CONF
HF CONF
HF/TOW CONF
TOW CONF
LA CONF
INCREASE IN EQUIVALENT FLAT PLATE AREA ABOVE CLEAN CONFIGURATION (SQ FT)
TRUE AIRSPEED (KNOTS)
0
1
2
3
4
5
6
7
8
9
10
11
12
60
70
80
90
100
110
120
130
140

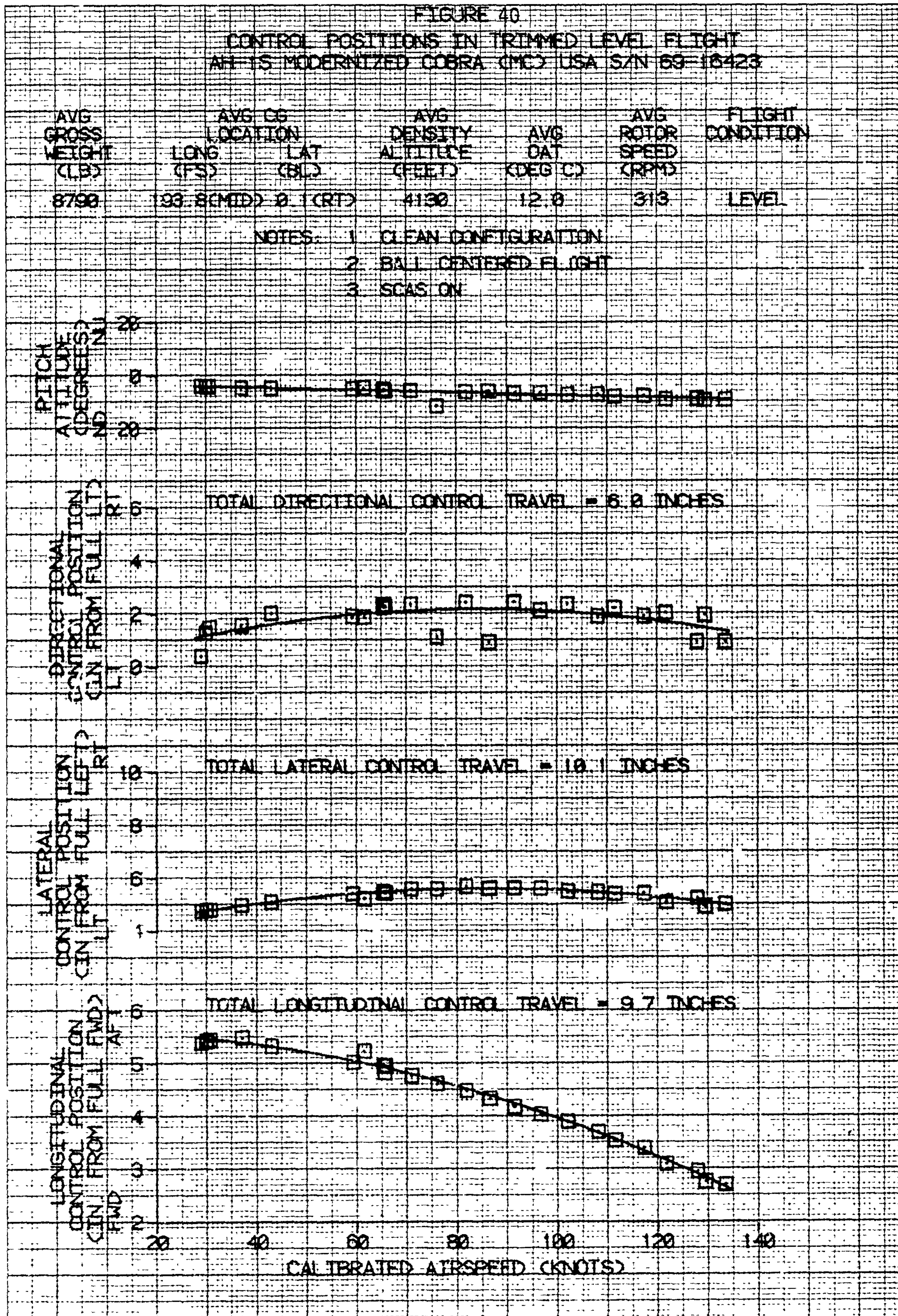


FIGURE 40
CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENSITY ALTITUDE (FEET)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
FLIGHT CONDITION
8790
193.8(MID)
0.1(RT)
4130
12.0
313
LEVEL
NOTES: 1. CLEAN CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON
PITCH ATTITUDE (DEGREES)
NU
ND
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.0 INCHES
DIRECTIONAL CONTROL POSITION (IN FROM FULL LT)
RT
LT
TOTAL LATERAL CONTROL TRAVEL = 10.1 INCHES
LATERAL CONTROL POSITION (IN FROM FULL LEFT)
TOTAL LONGITUDINAL CONTROL TRAVEL = 9.7 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
CALIBRATED AIRSPEED (KNOTS)

FIGURE 41
CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (FS) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 8820 | 195.3(MID) | 0.4(LT) | 3140 | 15.5 | 315 | LEVEL |

NOTES: 1. LAUNCHER CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

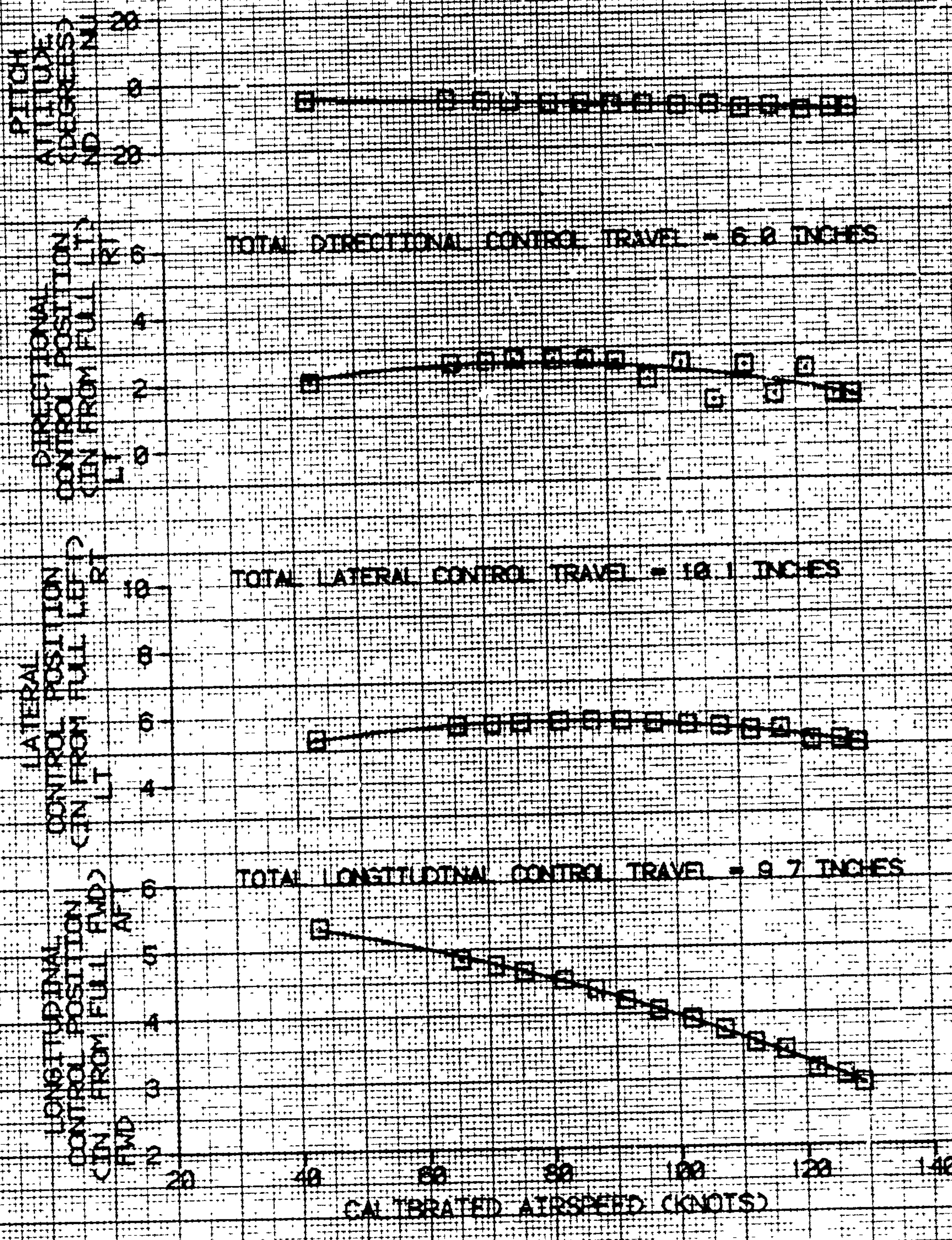


FIGURE 42
CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 8990 | 195.4(MID) | 1.0(RT) | 2340 | 14.5 | 315 | LEVEL |

NOTES: 1. TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

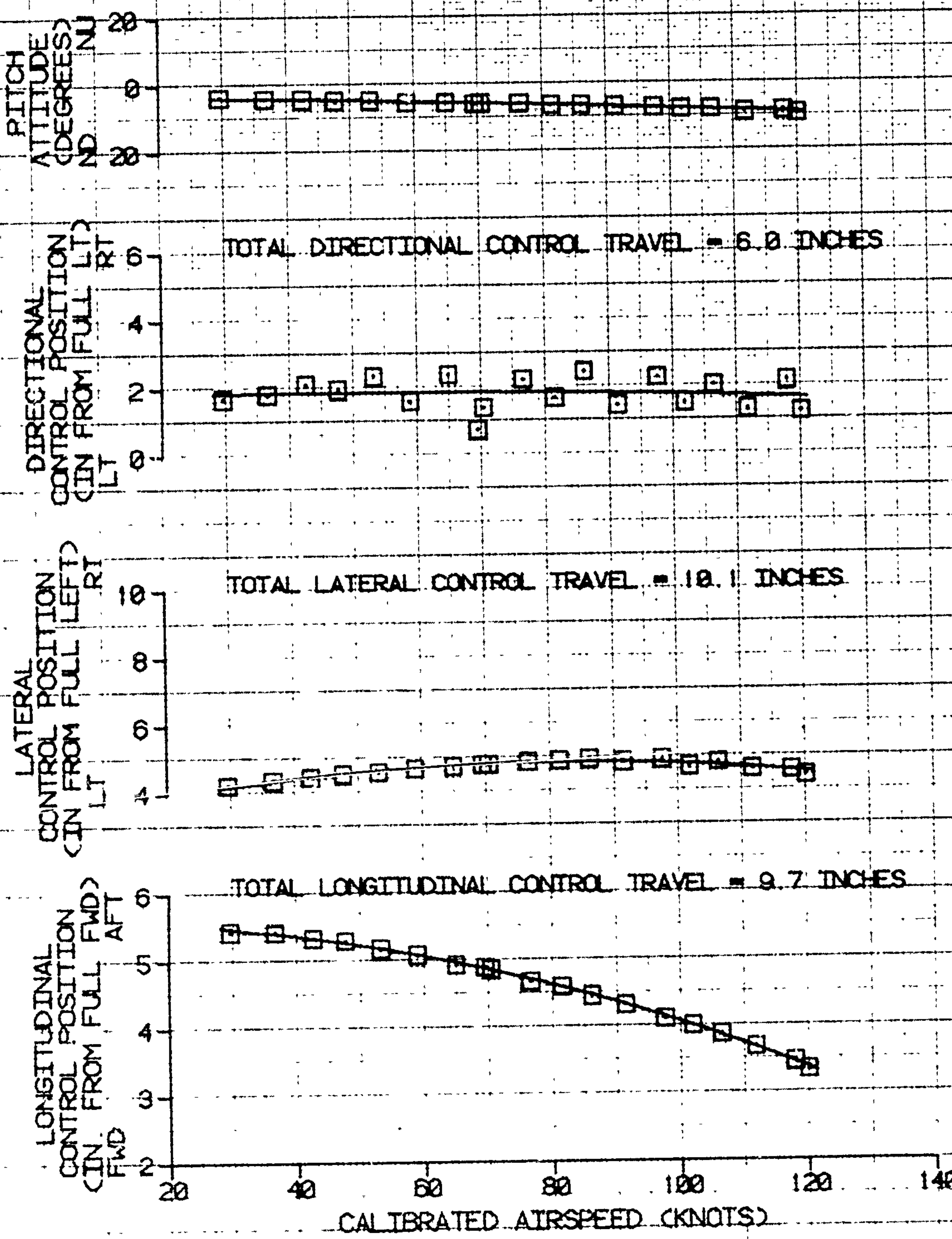


FIGURE 43
CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9700 | 195.5(MID) | 2.7(LT) | 8850 | 6.5 | 310 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

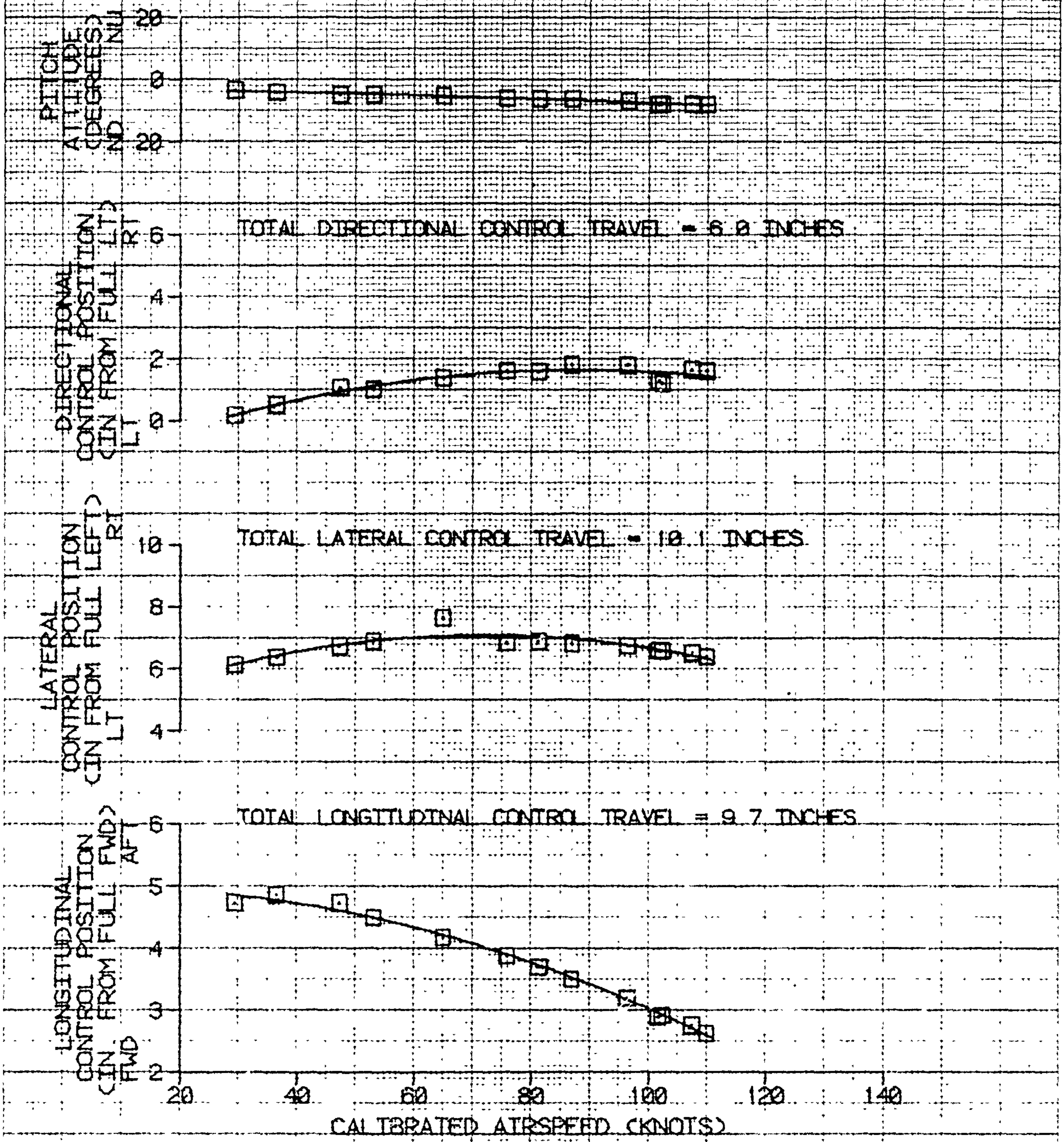


FIGURE 44

CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9140 | 194.1(MID) | 1.6(LT) | 2350 | 19.0 | 318 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

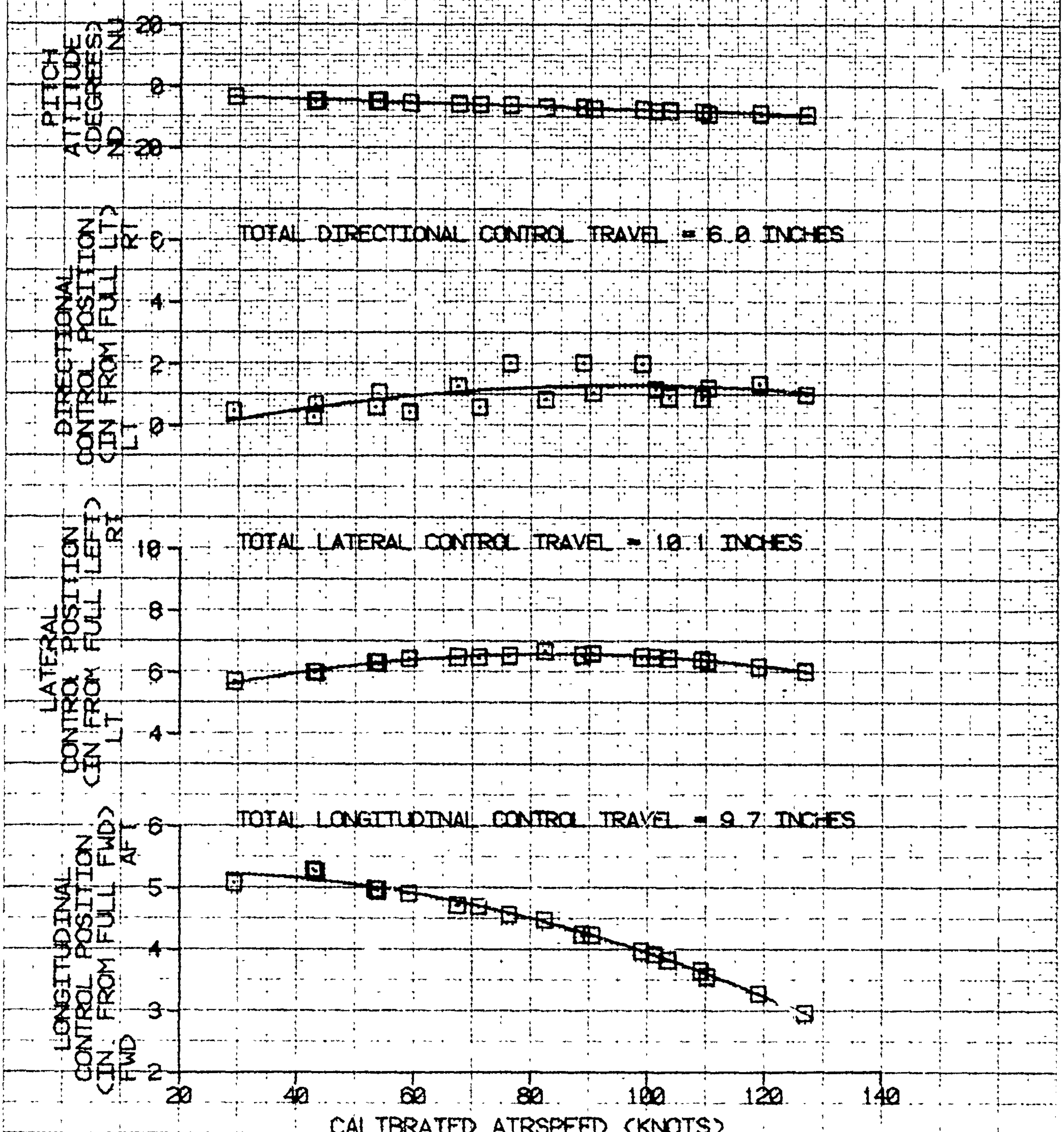


FIGURE 45

CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9290 | 194.6(MID) | 1.6(LT) | 2600 | 16.0 | 316 | LEVEL |

NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

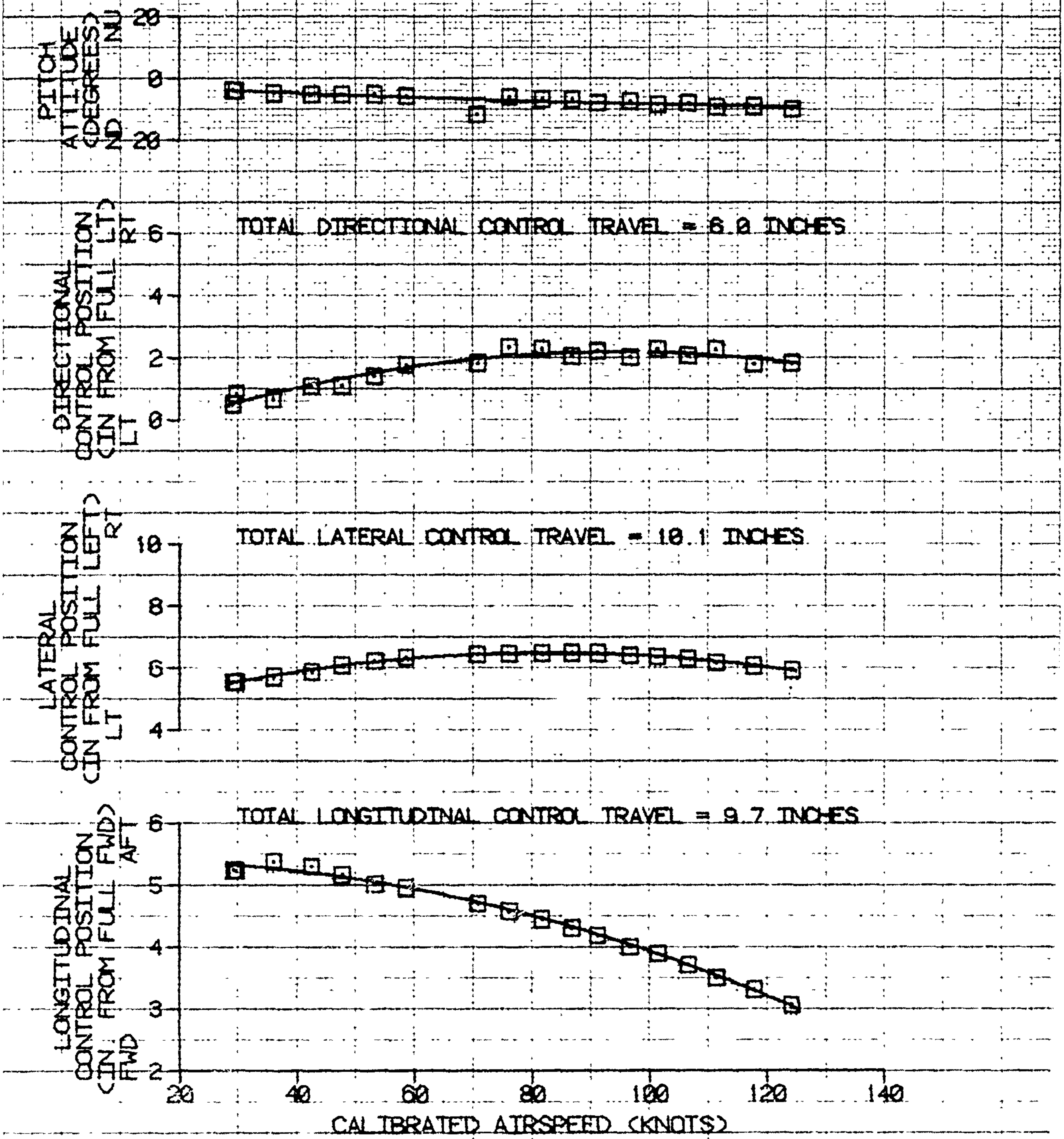


FIGURE 46

STATIC LONGITUDINAL STABILITY

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9829 | 195.9(MID) | 1.6(LT) | 7710 | 22.5 | 321 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

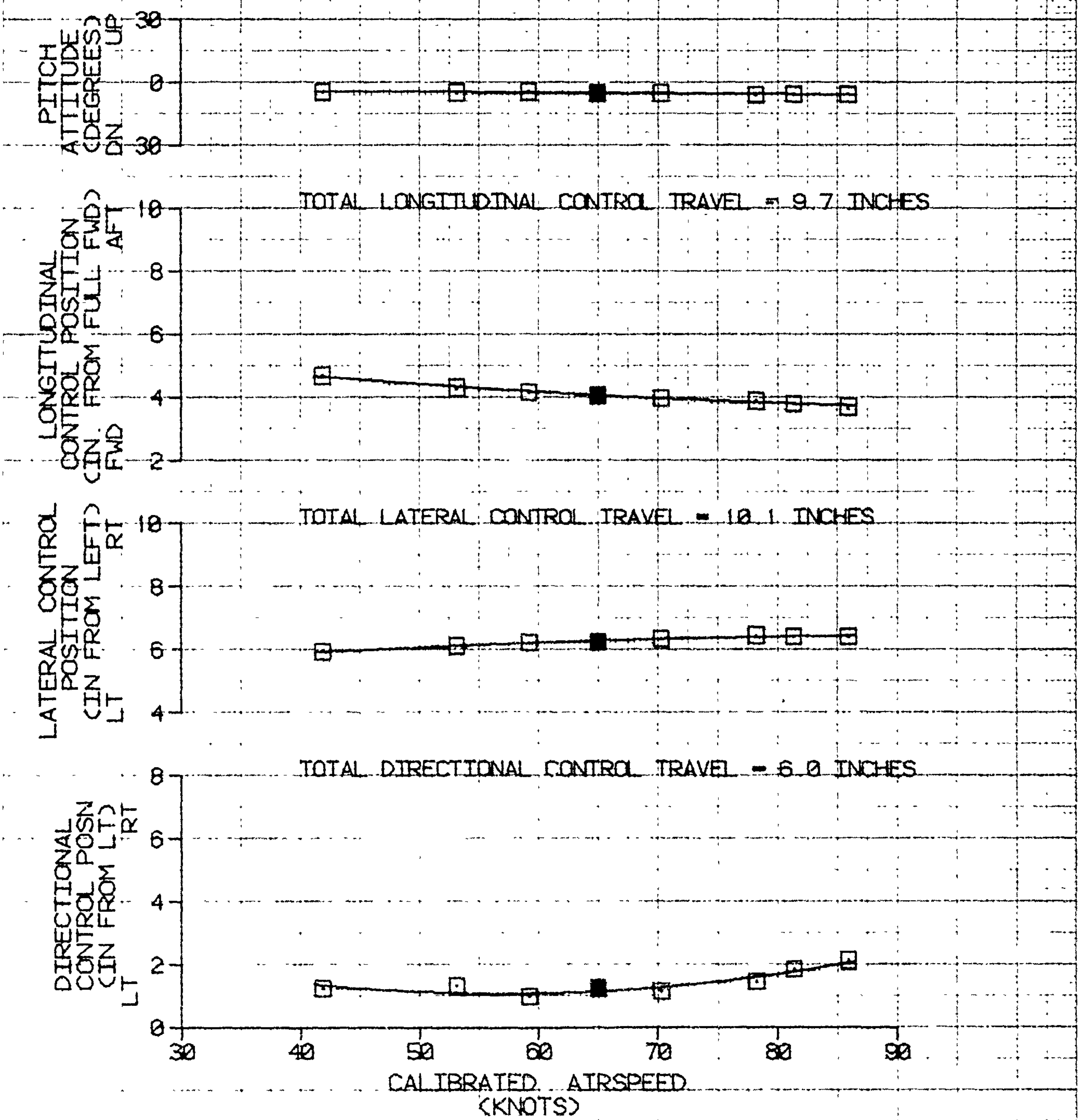


FIGURE 47

STATIC LONGITUDINAL STABILITY

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9650 | 195.9(MID) | 1.6(LT) | 7580 | 23.0 | 320 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

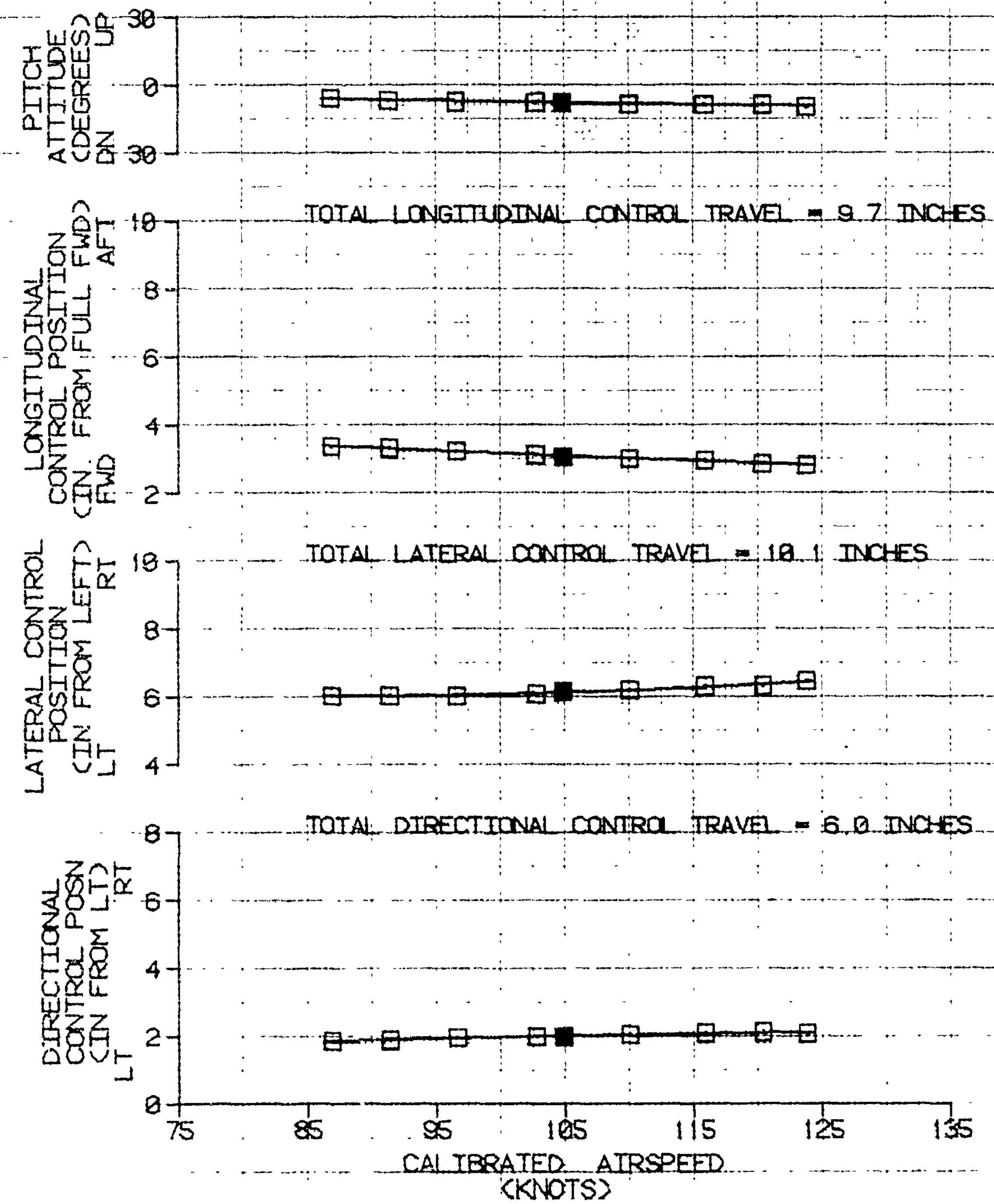


FIGURE 48

STATIC LONGITUDINAL STABILITY

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 10000 | 198.2(MID) | 1.6(LT) | 6240 | 23.0 | 320 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

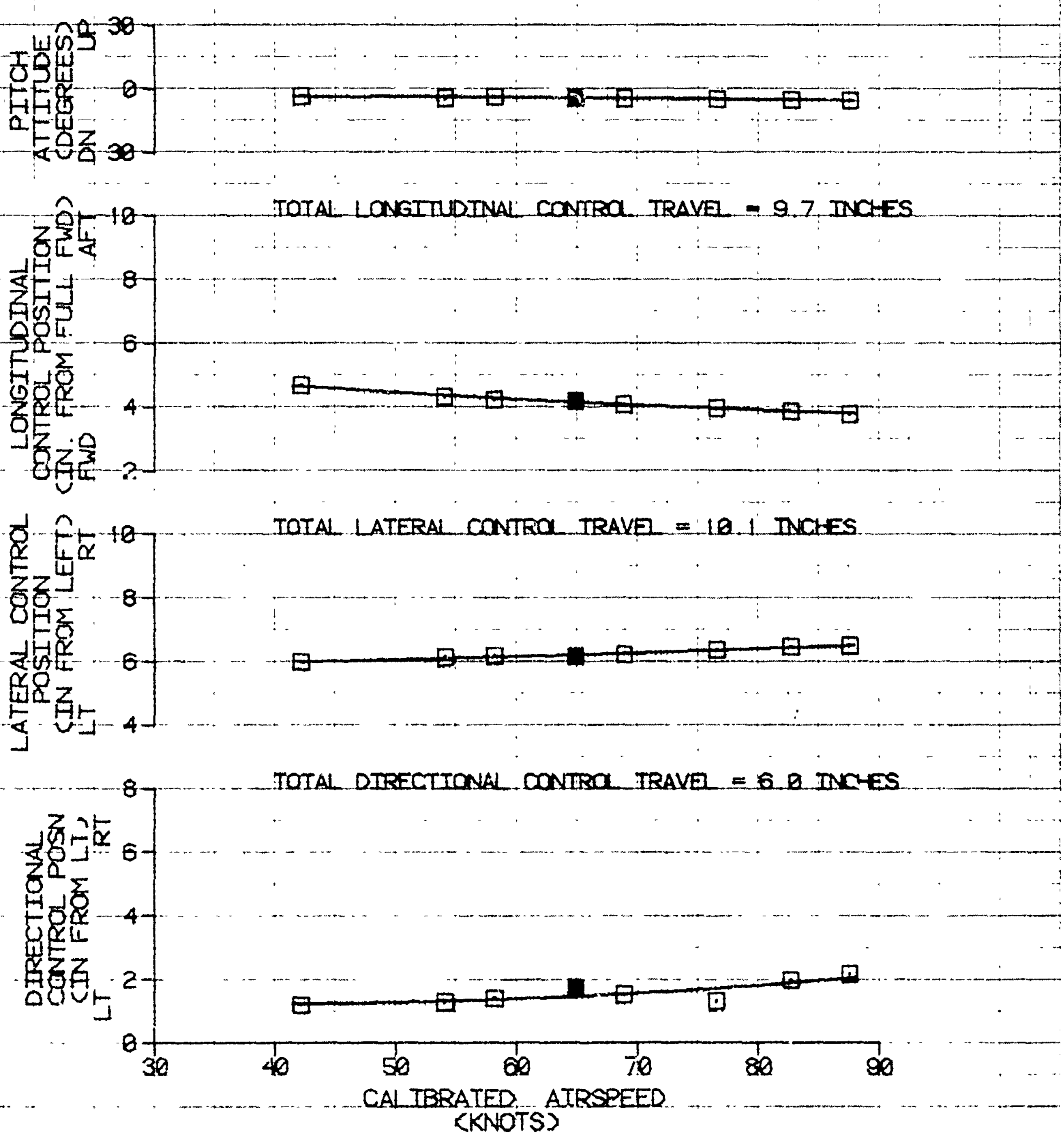


FIGURE 49
STATIC LONGITUDINAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9720 | 198.2(MID) | 1.6(LT) | 5820 | 23.5 | 318 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

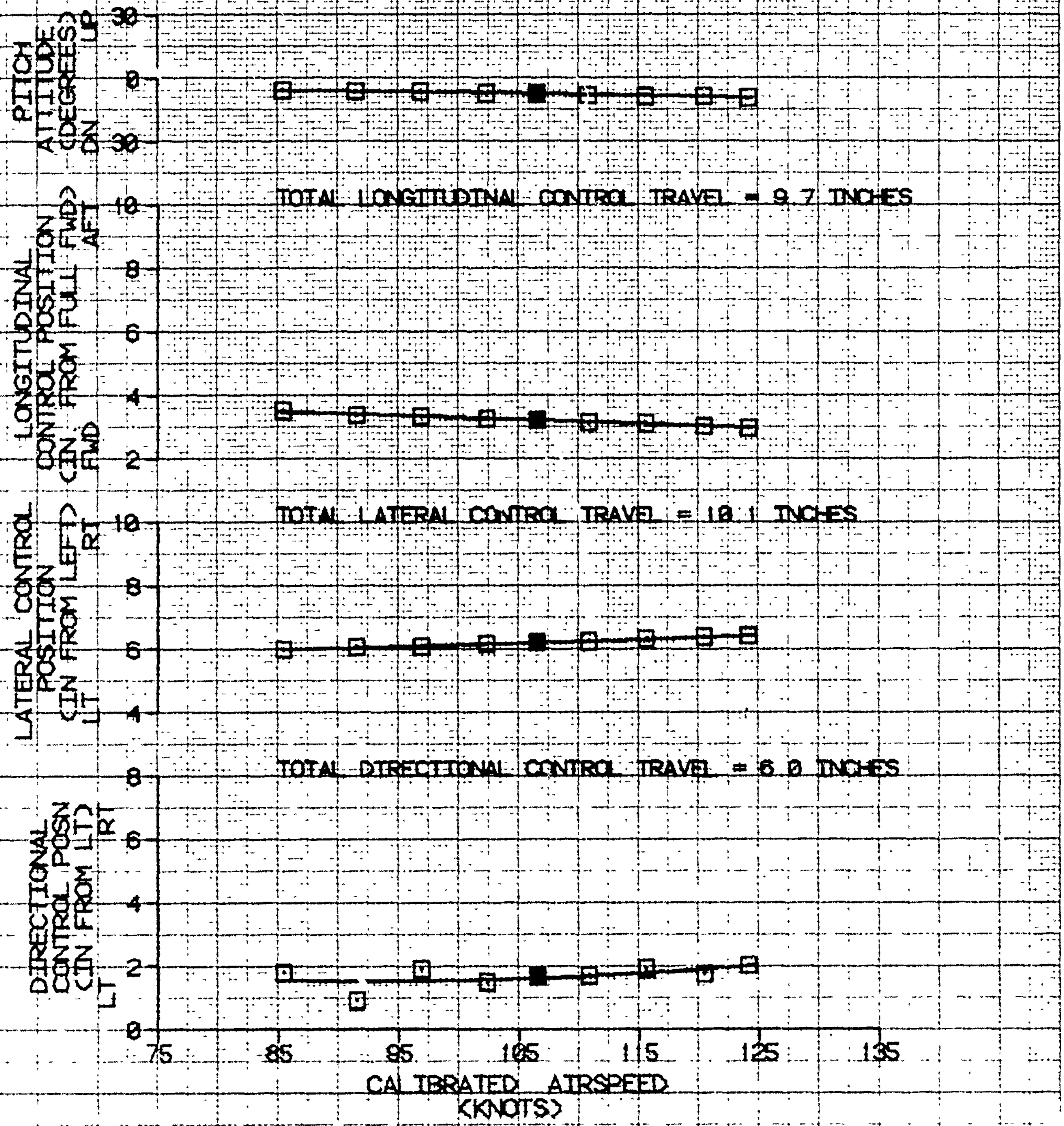


FIGURE 50
STATIC LONGITUDINAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 10180 | 196.5(MID) | 1.5(LT) | 7630 | 16.5 | 321 | LEVEL |

NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

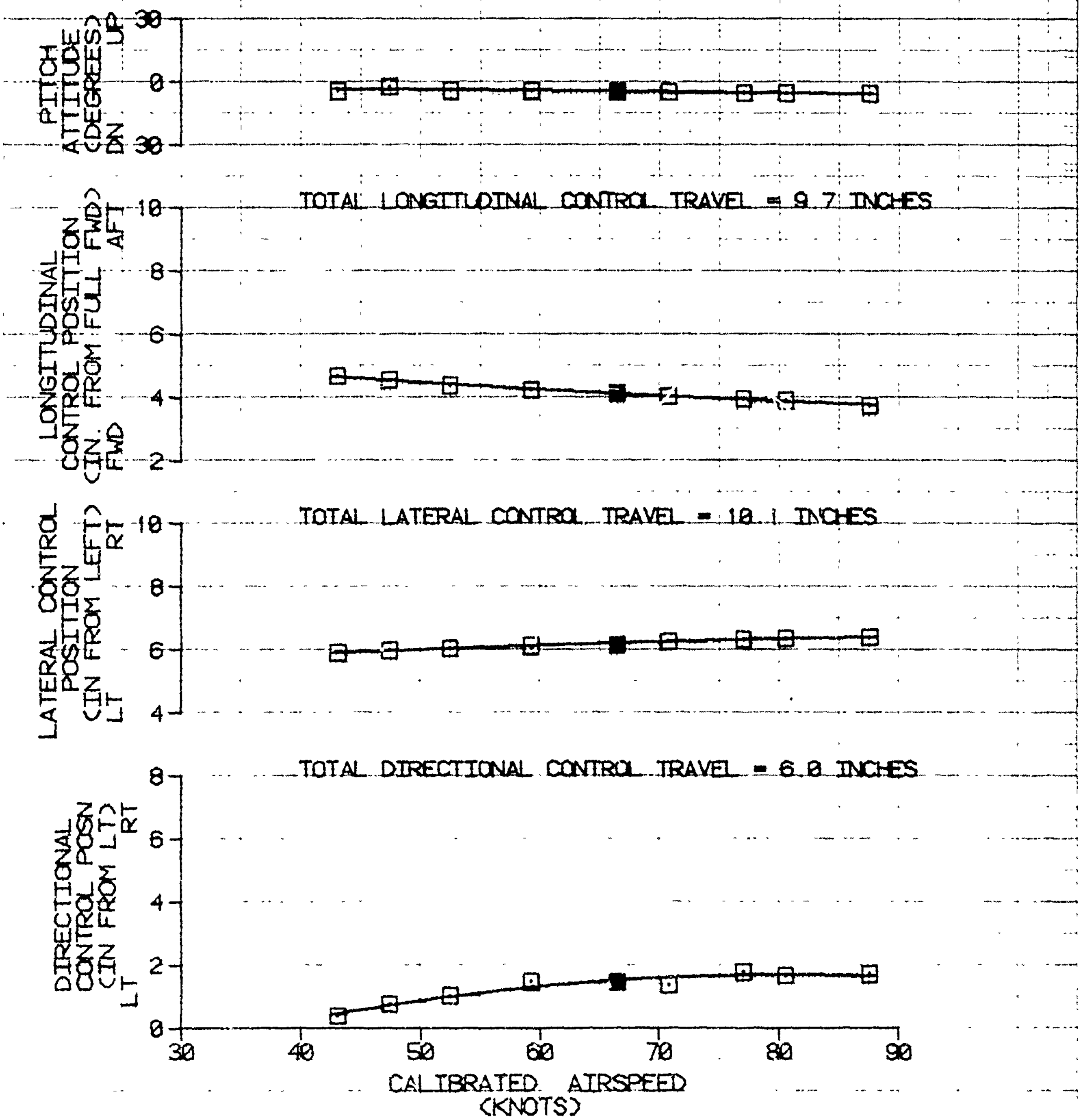
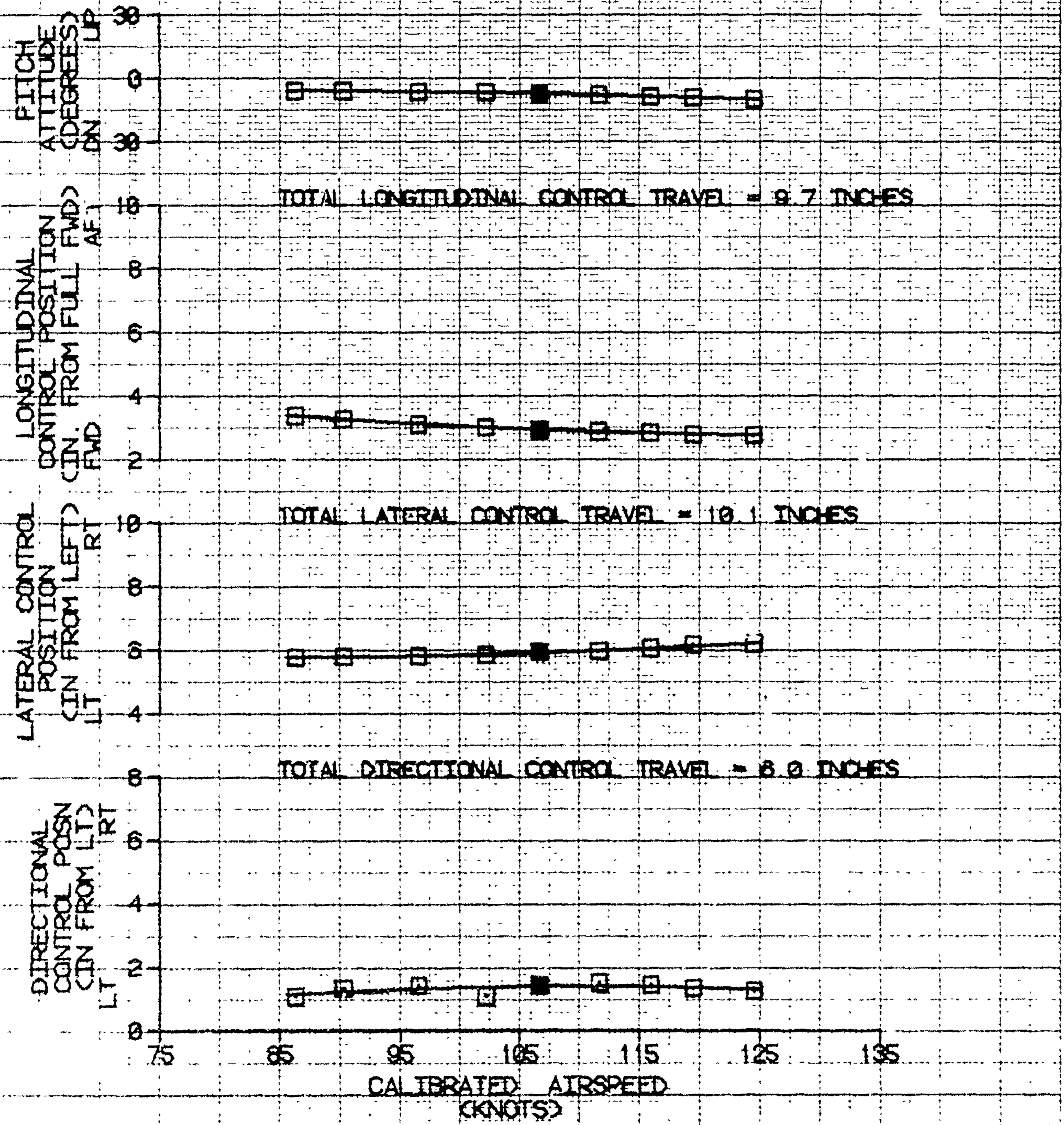


FIGURE 51
STATIC LONGITUDINAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9990 | 196.5(MID) | 1.5(LT) | 8170 | 15.5 | 322 | LEVEL |

NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON



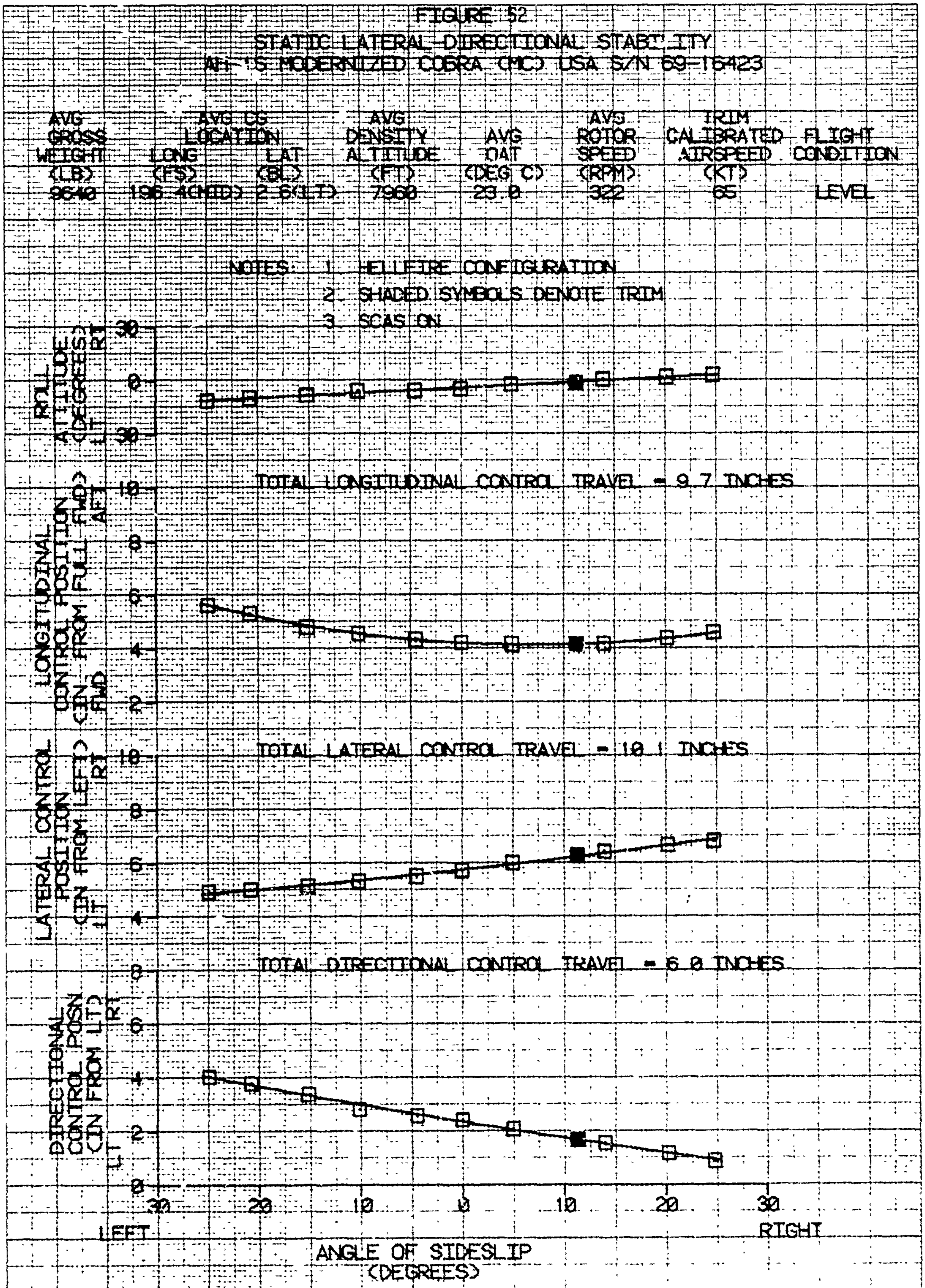


FIGURE 52
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9640
AVG CG LOCATION LONG (FS) 196.4(MID) LAT (BL) 2.6(LT)
AVG DENSITY ALTITUDE (FT) 7960
AVG OAT (DEG C) 23.0
AVG ROTOR SPEED (RPM) 322
TRIM CALIBRATED AIRSPEED (KT) 65
FLIGHT CONDITION LEVEL
NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON
ROLL ATTITUDE (DEGREES)
RT
LT
TOTAL LONGITUDINAL CONTROL TRAVEL = 9.7 INCHES
LONGITUDINAL CONTROL POSITION (IN FROM FULL FWD)
AFT
FWD
TOTAL LATERAL CONTROL TRAVEL = 10.1 INCHES
LATERAL CONTROL POSITION (IN FROM LEFT)
RT
LT
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.0 INCHES
DIRECTIONAL CONTROL POSN (IN FROM LT)
RT
LT
LEFT
RIGHT
ANGLE OF SIDESLIP (DEGREES)

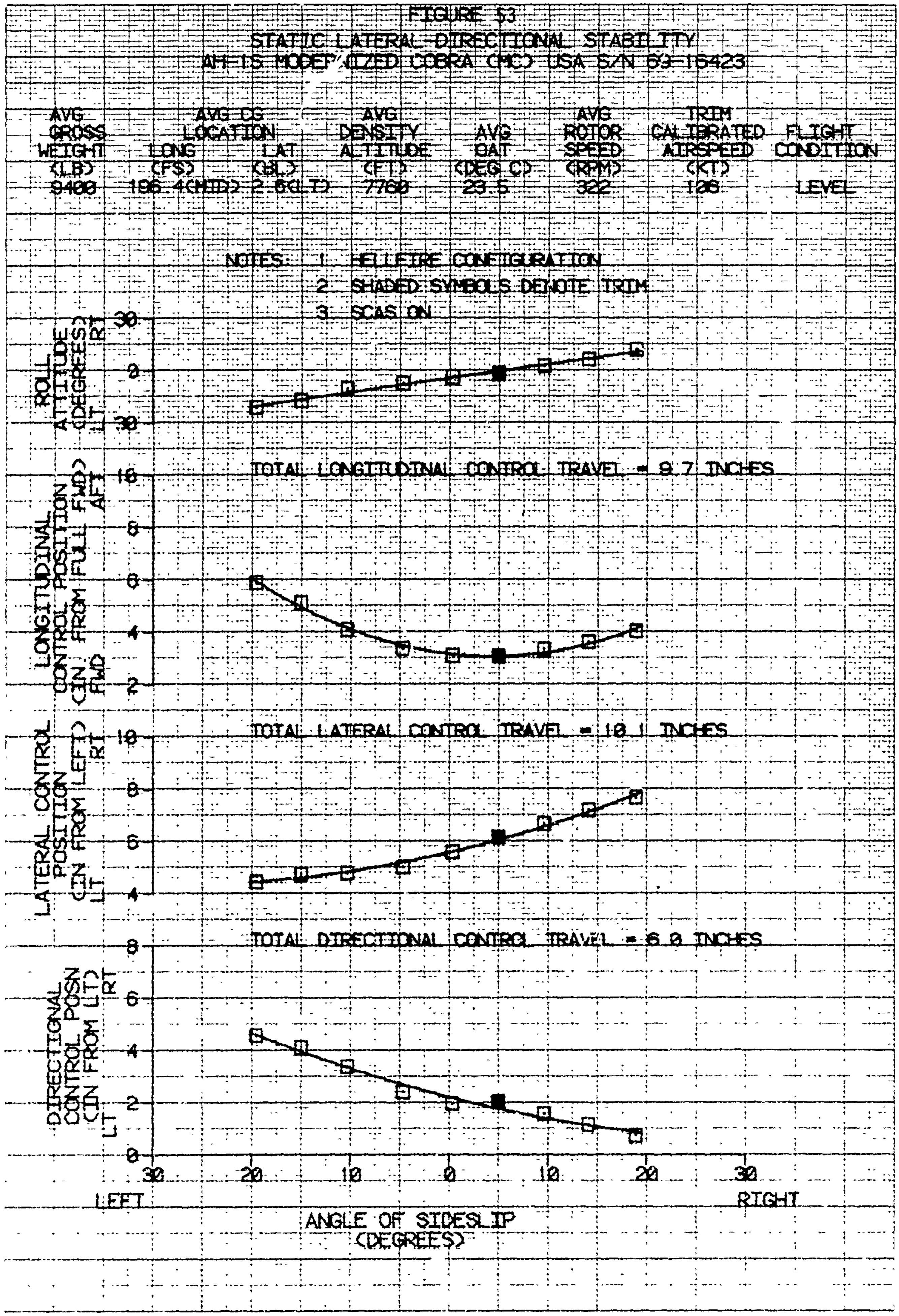


FIGURE 53
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9400
AVG CG LOCATION LONG (FS) 196.4(MID) LAT (BL) 2.6(LT)
AVG DENSITY ALTITUDE (FT) 7760
AVG OAT (DEG C) 23.5
AVG ROTOR SPEED (RPM) 322
TRIM CALIBRATED AIRSPEED (KT) 120
FLIGHT CONDITION LEVEL
NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON
ROLL ATTITUDE (DEGREES) LT RT
TOTAL LONGITUDINAL CONTROL TRAVEL = 9.7 INCHES
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD) FWD AFT
TOTAL LATERAL CONTROL TRAVEL = 10.1 INCHES
LATERAL CONTROL POSITION (IN FROM LEFT) LT RT
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.0 INCHES
DIRECTIONAL CONTROL POSN (IN FROM LT) LT RT
LEFT
RIGHT
ANGLE OF SIDESLIP (DEGREES)

FIGURE 54
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9940 | 198.2(MID) | 1.6(LT) | 7880 | 18.0 | 320 | 65 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

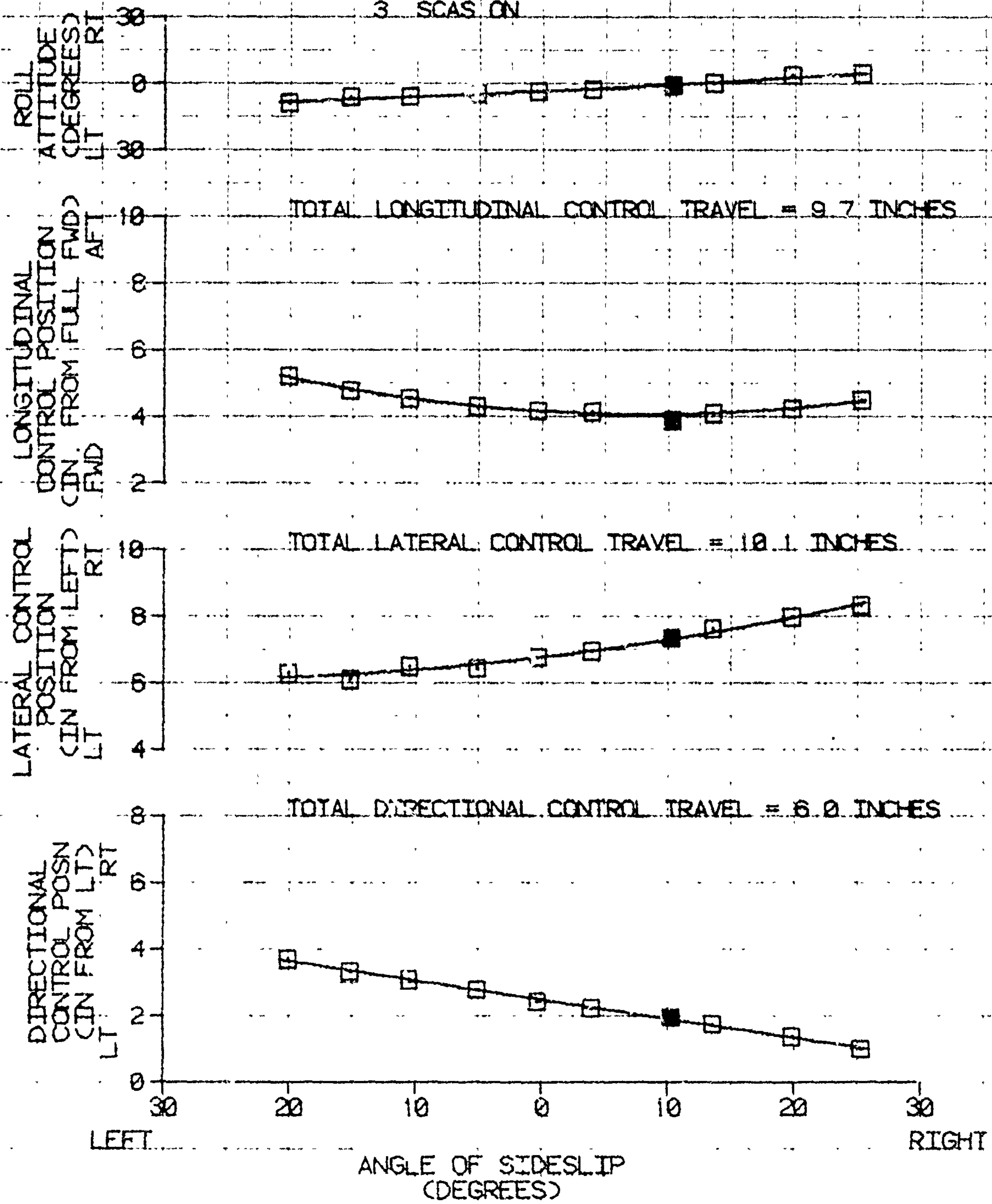


FIGURE 55
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9640 | 198.2(MID) | 1.6(LT) | 7640 | 18.5 | 319 | 106 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

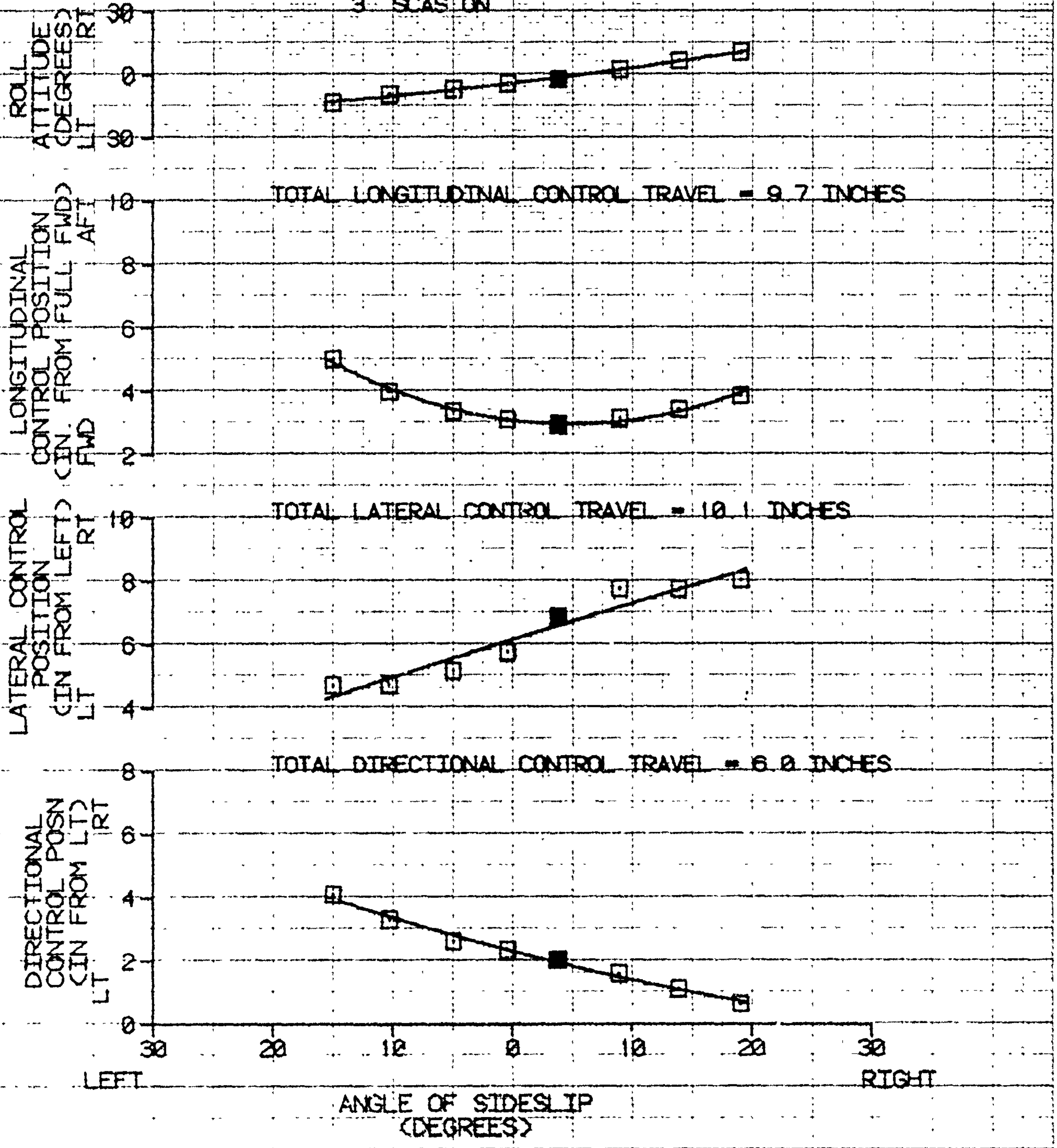


FIGURE 56
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 10100 | 194.9(MID) | 1.5(LT) | 7840 | 17.5 | 322 | 65 | LEVEL |

NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

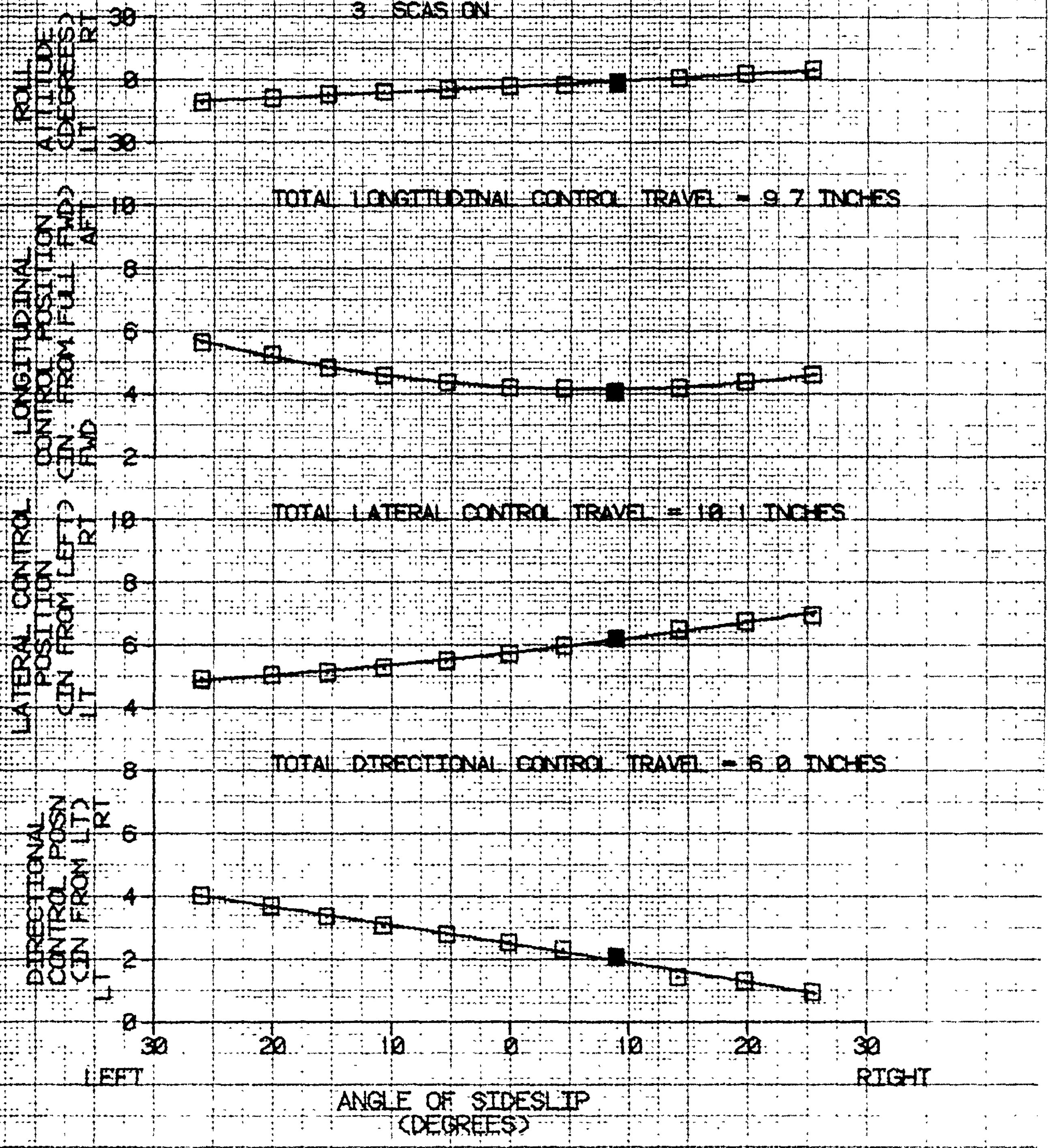


FIGURE 57
STATIC LATERAL-DIRECTIONAL STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9720 | 194.9(MID) | 1.5(LT) | 7420 | 18.5 | 322 | 106 | LEVEL |

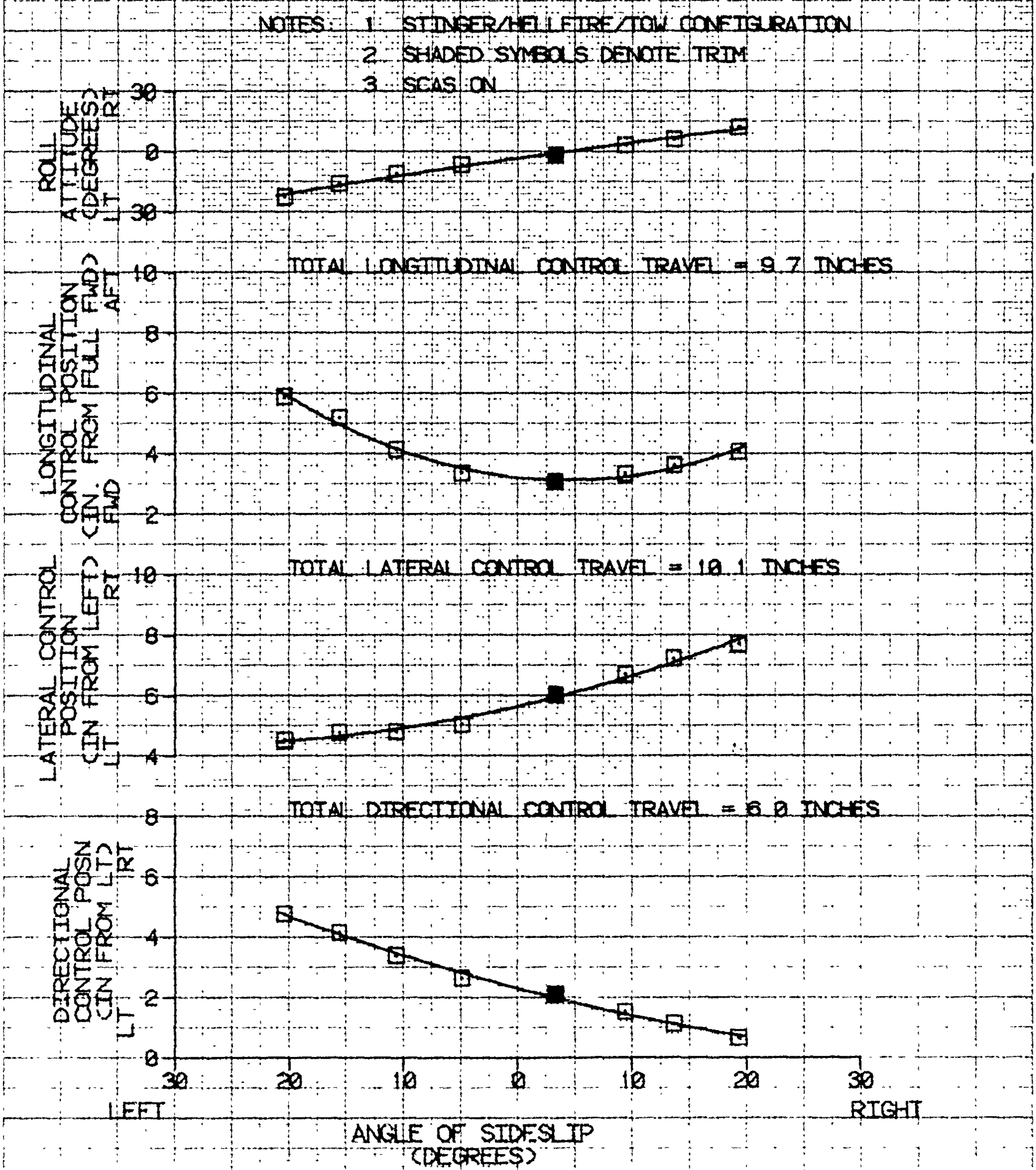


FIGURE 58
MANEUVERING STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | AVG CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9110 | 196.5(MID) | 2.8(LT) | 6480 | 20.0 | 324 | 107 | RIGHT TURN |

NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

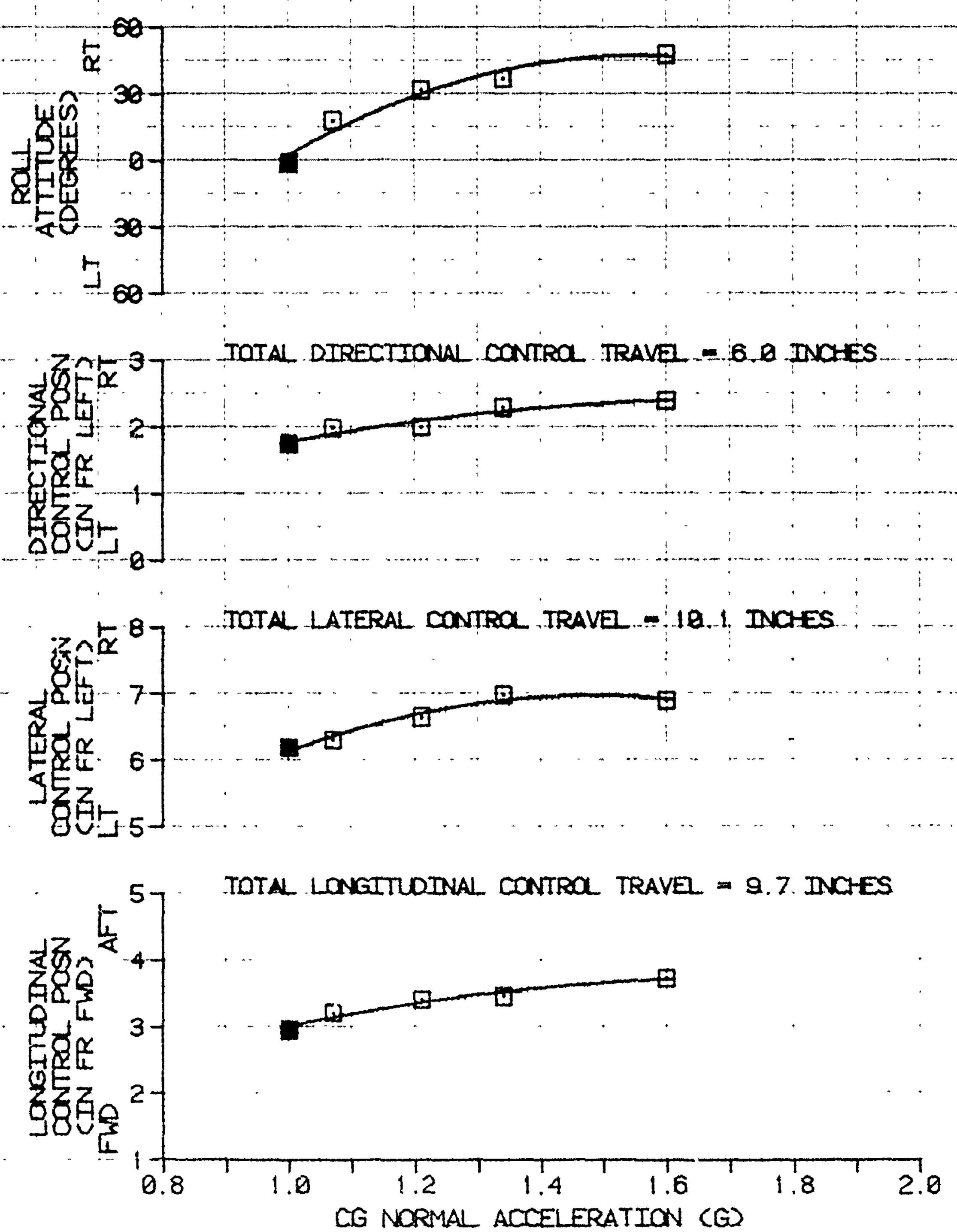


FIGURE 59

MANEUVERING STABILITY

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | AVG CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 8770 | 196.5(MID) | 2.8(LT) | 6280 | 20.5 | 324 | 109 | LEFT TURN |

NOTES: 1. HELLFIRE CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

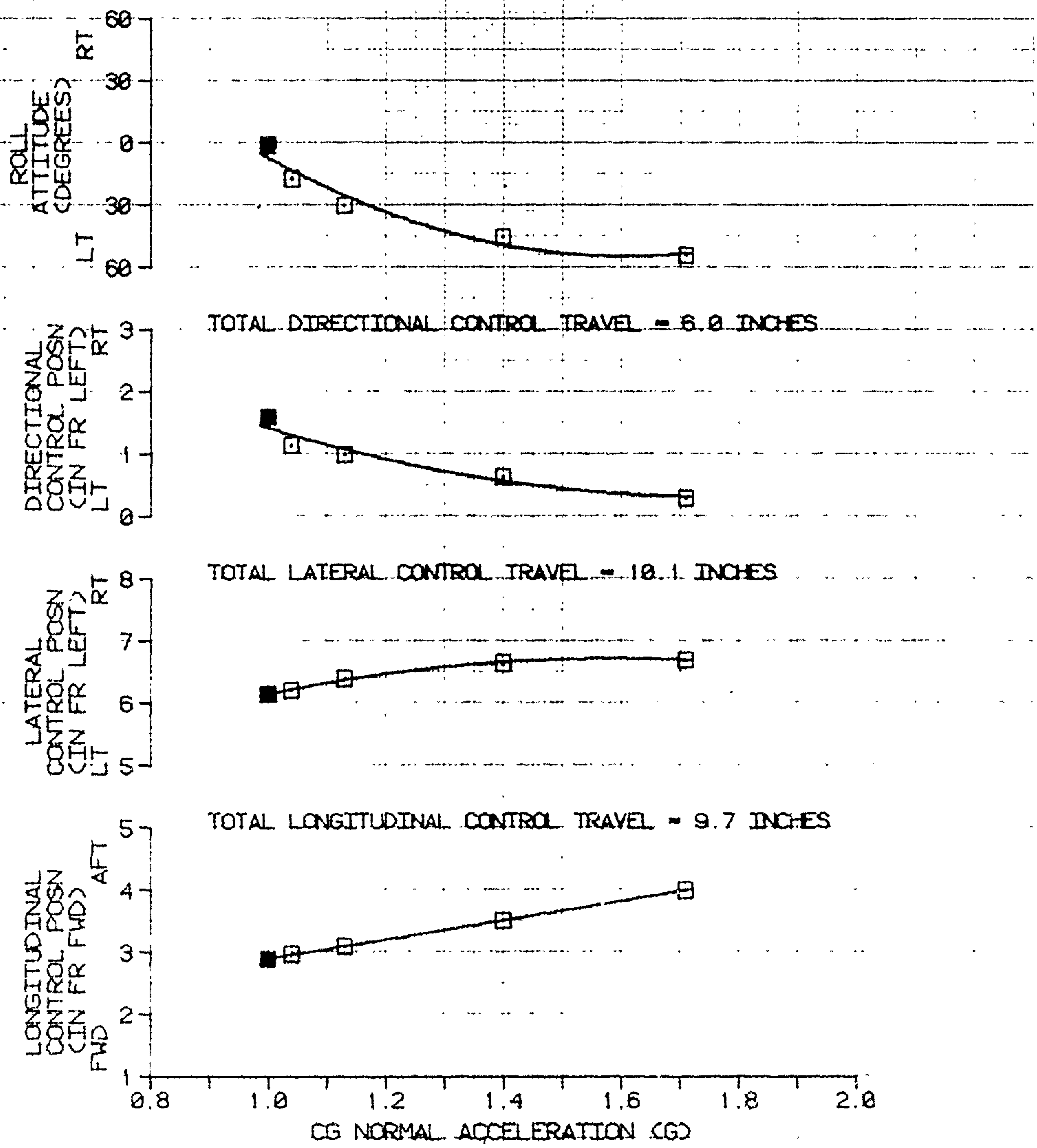


FIGURE 60

MANEUVERING STABILITY

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | AVG CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9630 | 196.9(MID) | 1.6(LT) | 7980 | 15.0 | 324 | 107 | RIGHT TURN |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

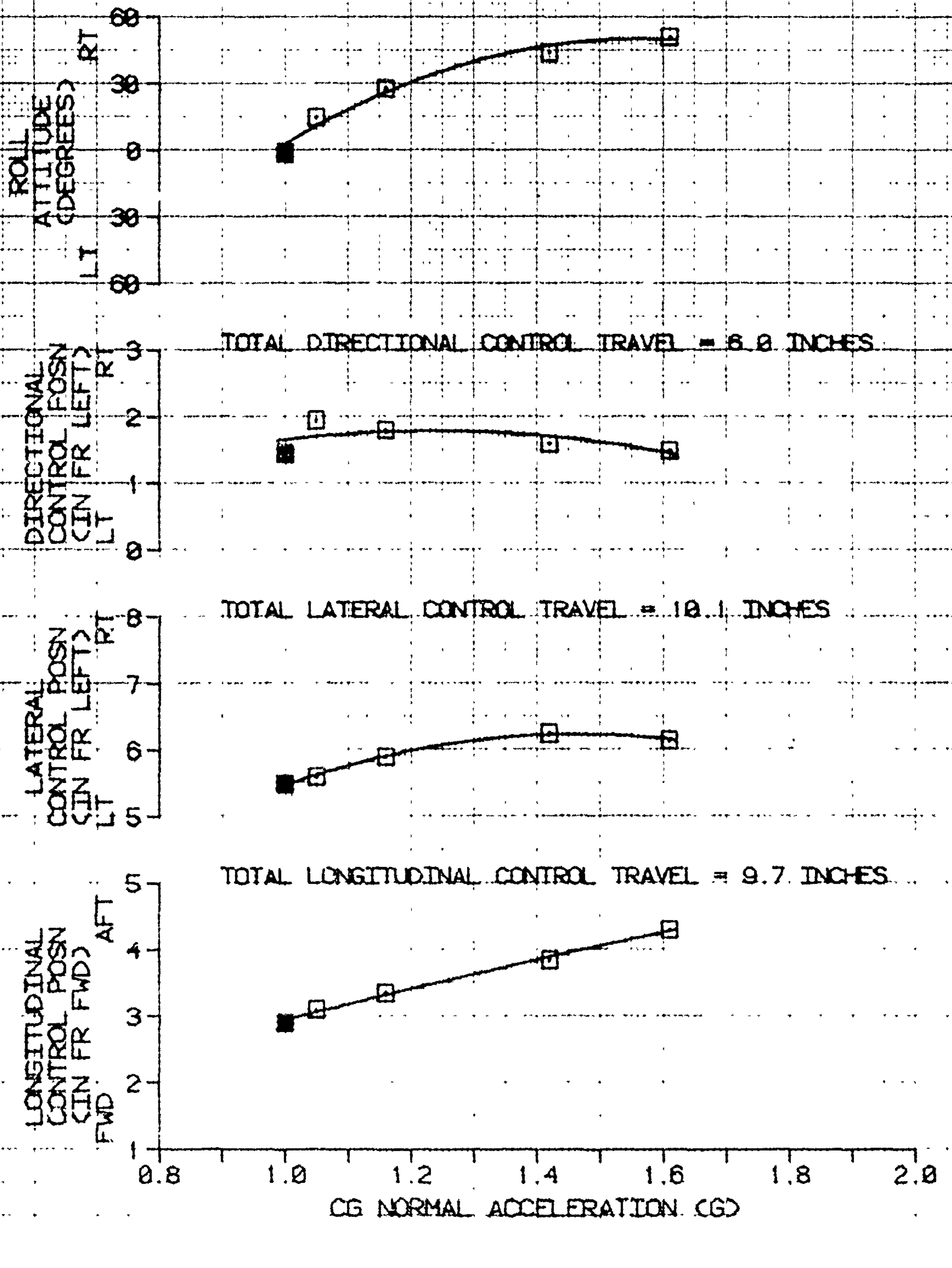


FIGURE 61
MANEUVERING STABILITY
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | AVG CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9840 | 197.1(MID) | 1.6(LT) | 8220 | 16.0 | 324 | 107 | LEFT TURN |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SHADED SYMBOLS DENOTE TRIM
3. SCAS ON

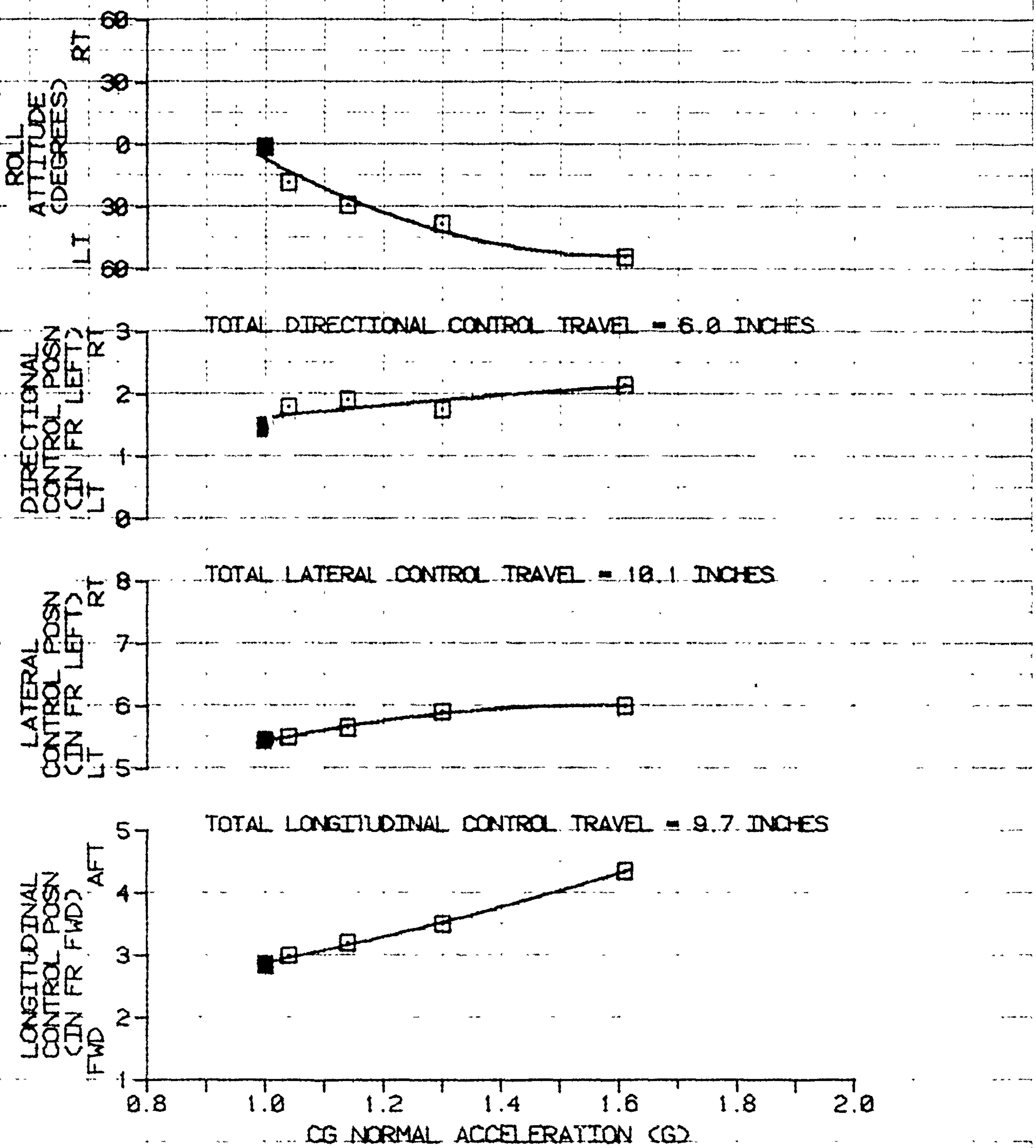


FIGURE 62

AFT LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9790 | 196 9(MID) | 2 6(LT) | 7970 | 22 0 | 322 | 65 | LEVEL |

NOTES 1 HELLFIRE CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

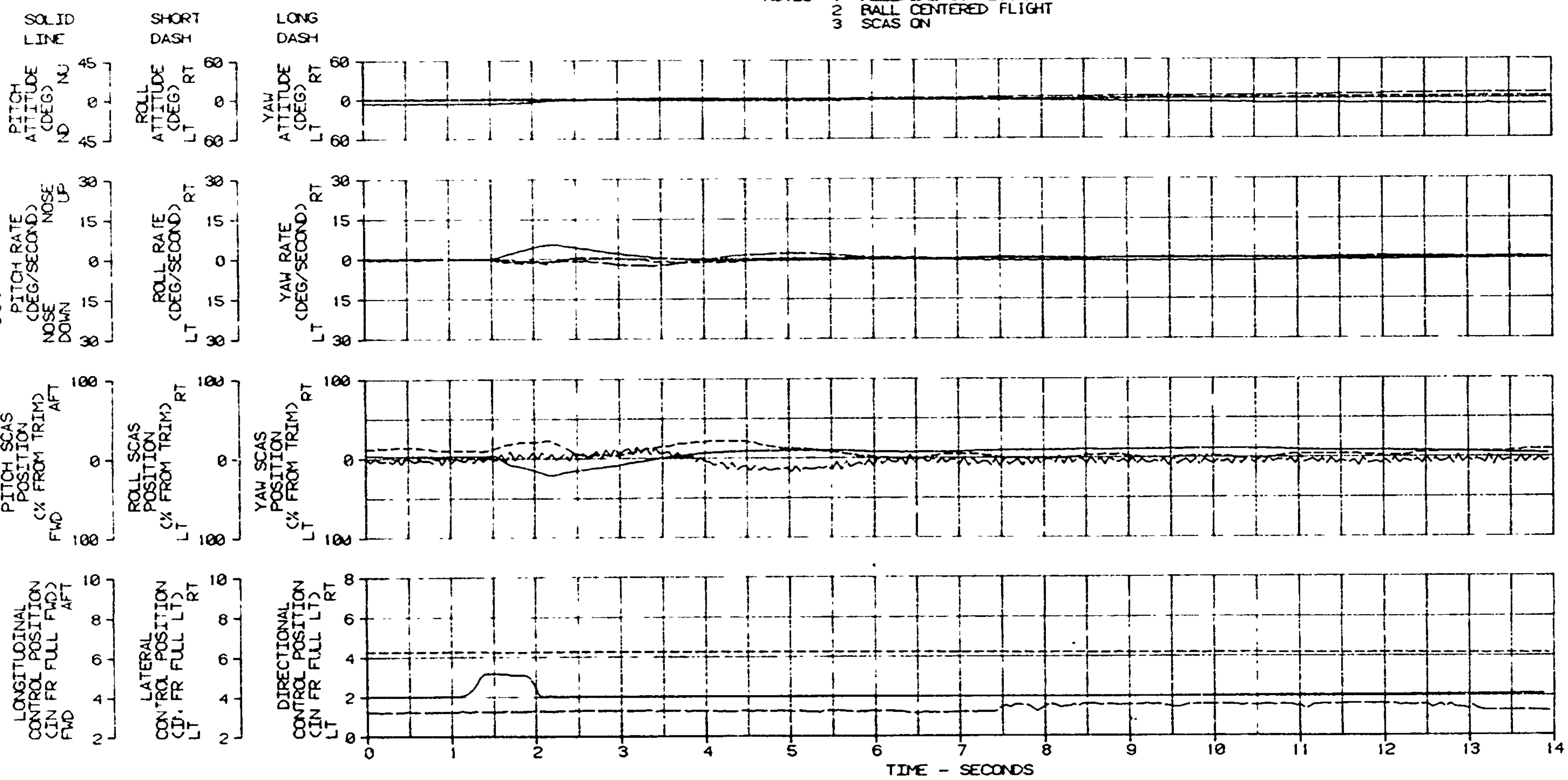


FIGURE 63

AFT LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9570 | 196 8(MID) | 2 7(LT) | 7540 | 23 5 | 323 | 105 | LEVEL |

NOTES: 1 HELLFIRE CONFIGURATION
2 BALL CENTERED FLIGHT
3. SCAS ON

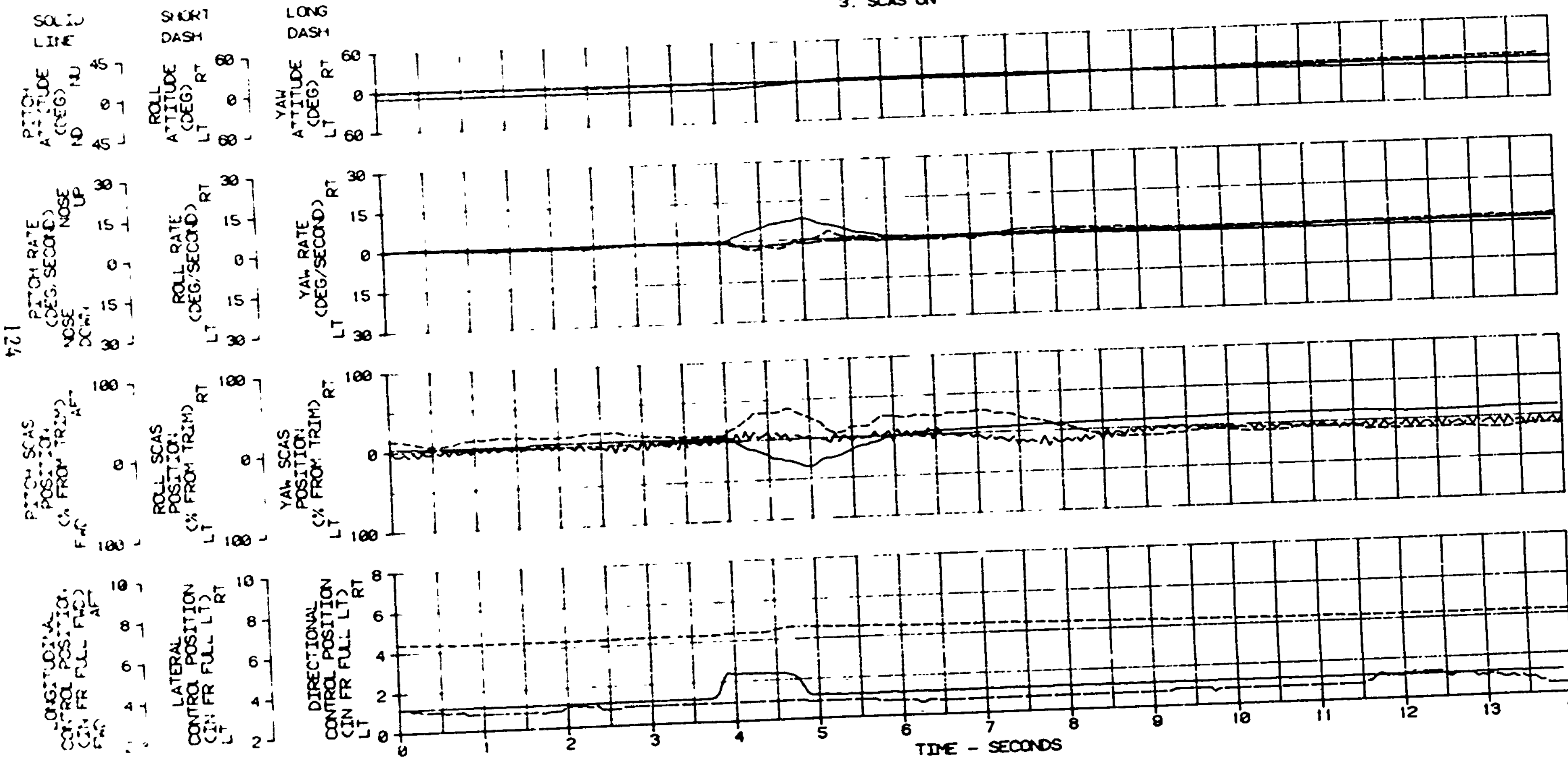


FIGURE 64

LEFT PEDAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9190 | 196 5(MID) | 2 8(LT) | 7410 | 24 0 | 321 | 66 | LEVEL |

NOTES 1 HELLFIRE CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS OFF

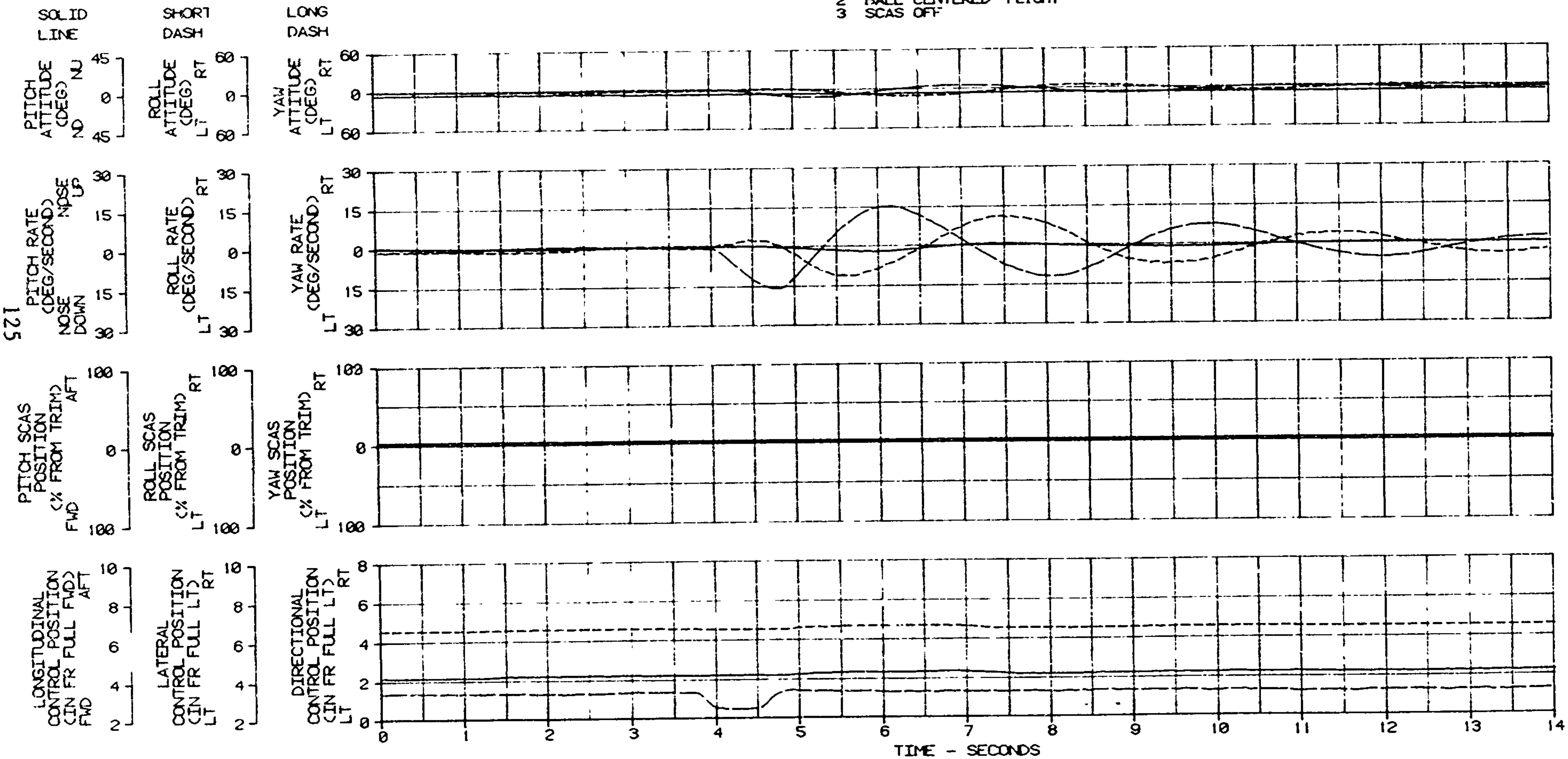


FIGURE 65

AFT LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9820 | 196 9(MID) | 1 5(LT) | 8240 | 15.0 | 322 | 105 | LEVEL |

NOTES. 1. HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

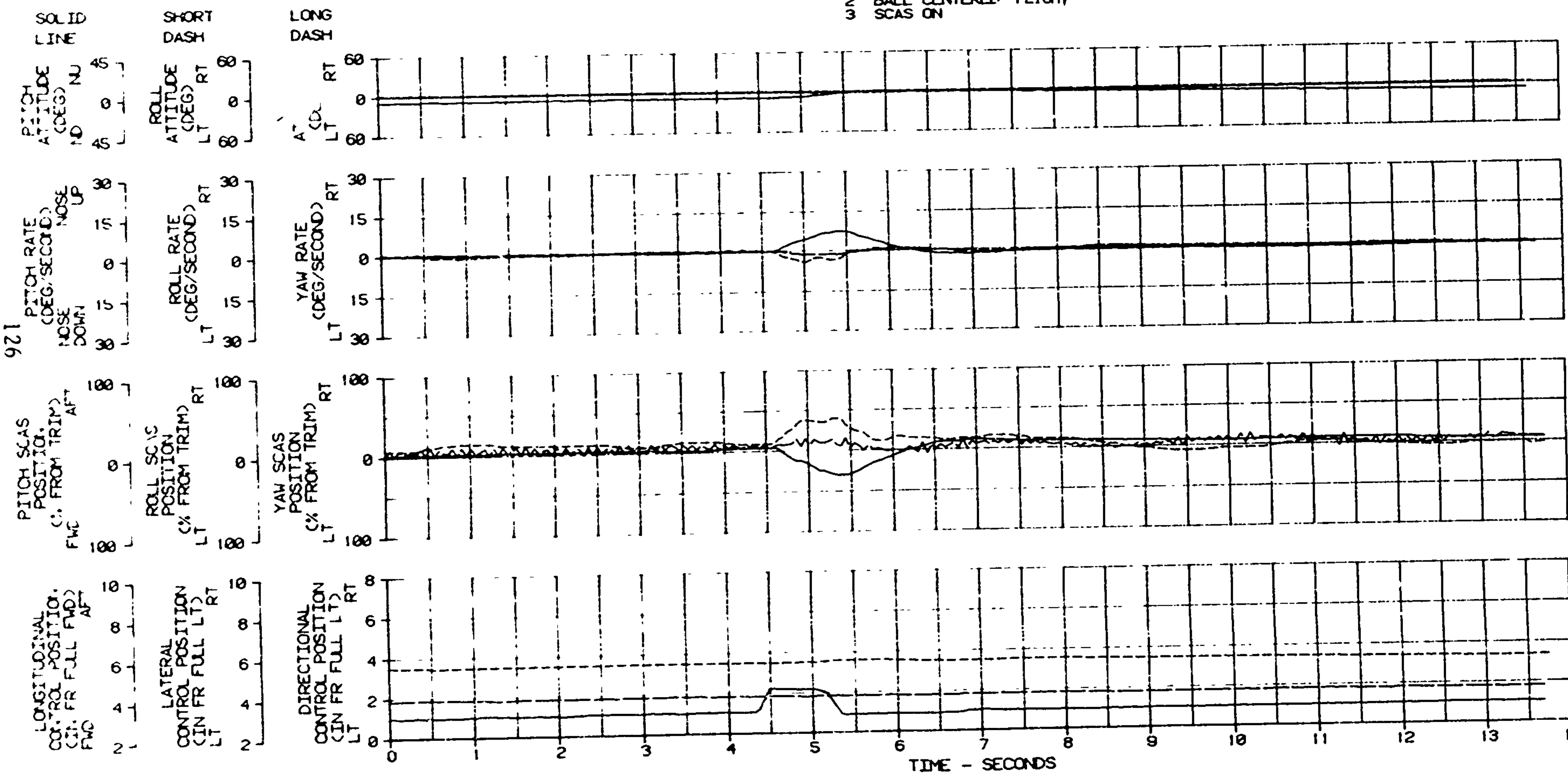


FIGURE 66

LEFT LATERAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9770 | 196 9(MID) | 1 5(LT) | 7840 | 16 0 | 322 | 108 | LEVEL |

NOTES 1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

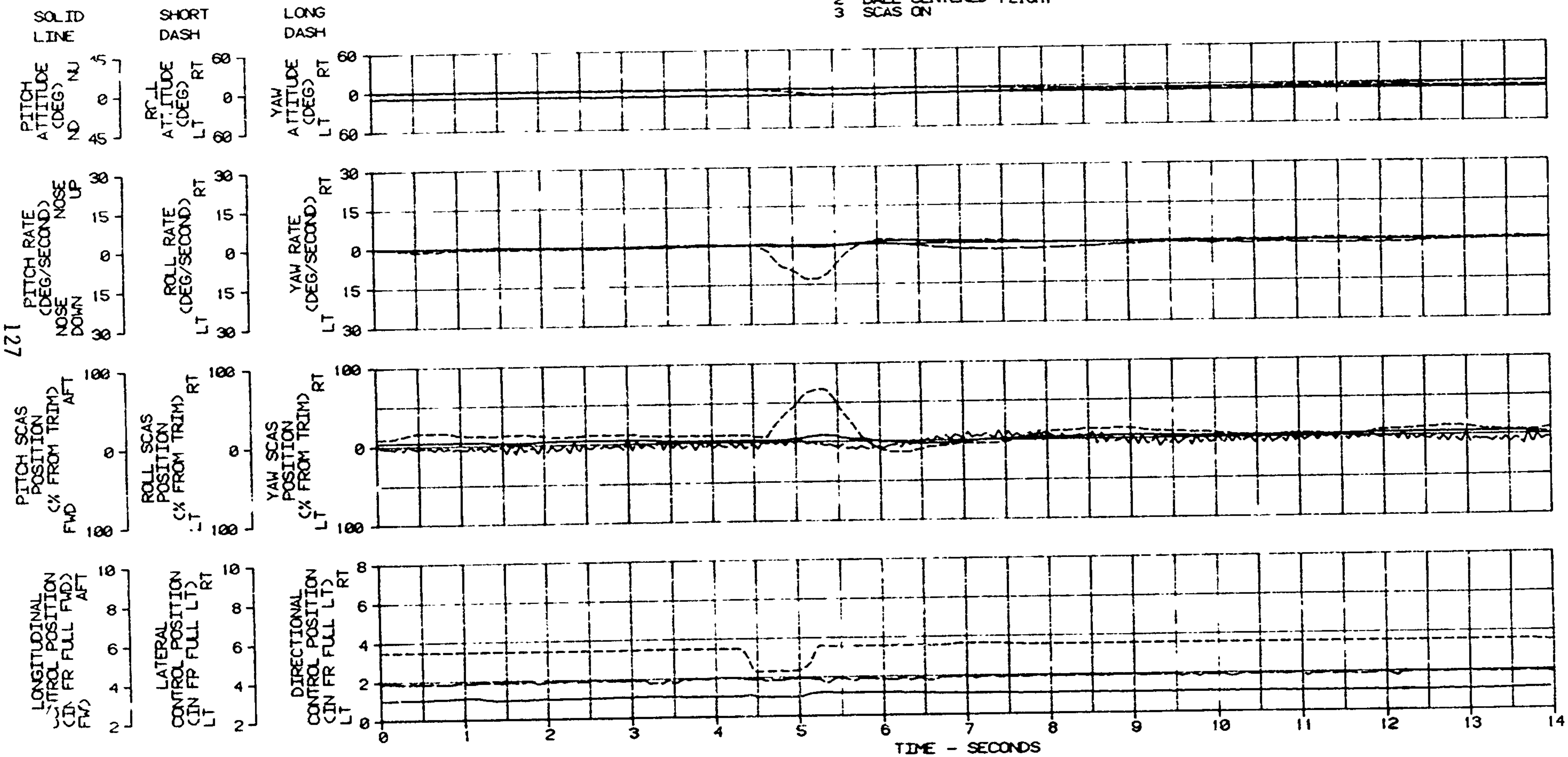


FIGURE 67

AFT LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9590 | 196 7(MID) | 1 6(LT) | 7960 | 15 5 | 323 | 85 | LEVEL |

NOTES 1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3. SCAS OFF

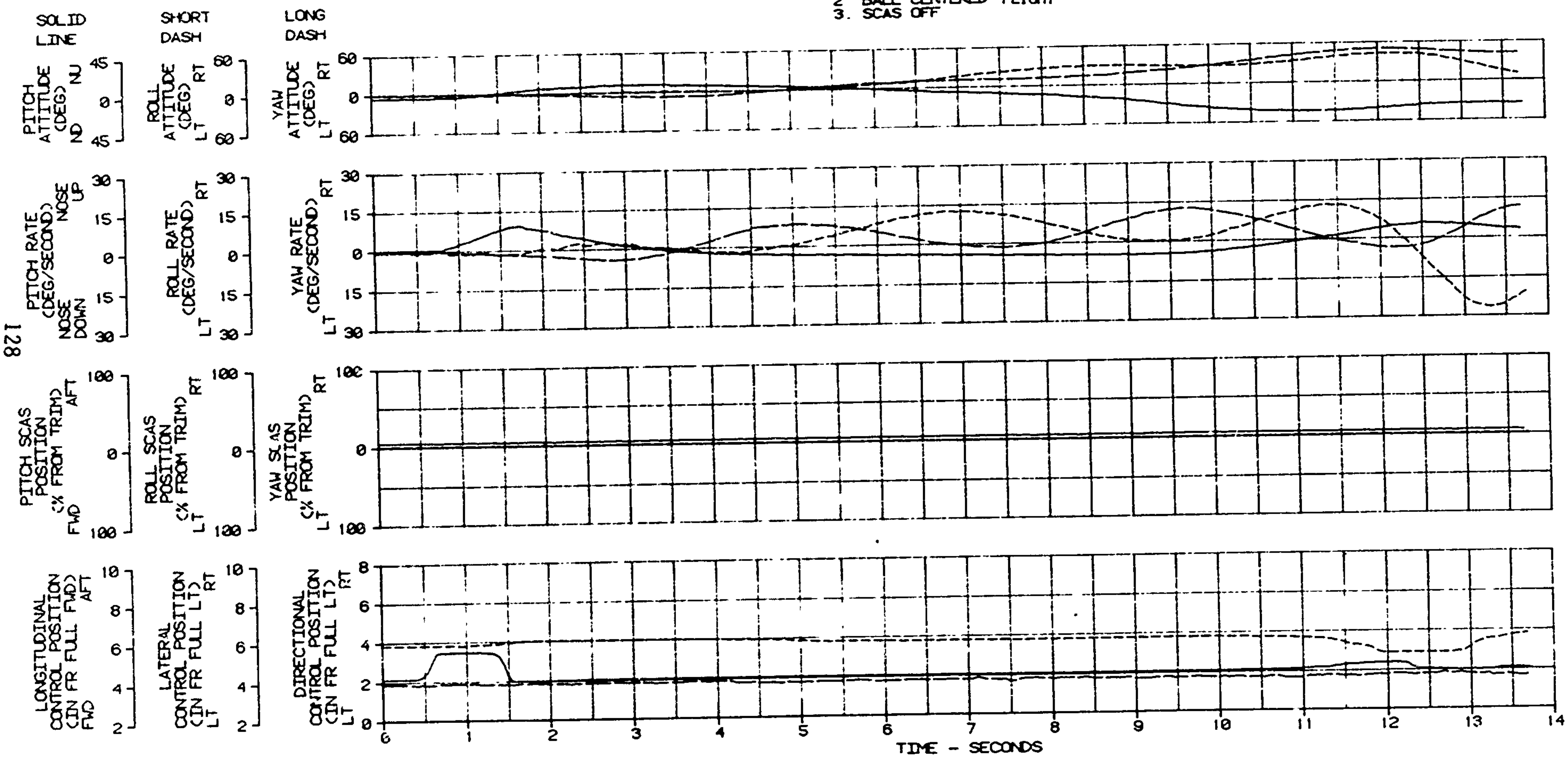


FIGURE 68

FORWARD LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9370 | 196 6(MID) | 1 7(LT) | 7960 | 15 0 | 323 | 86 | LEVEL |

NOTES 1. HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS OFF

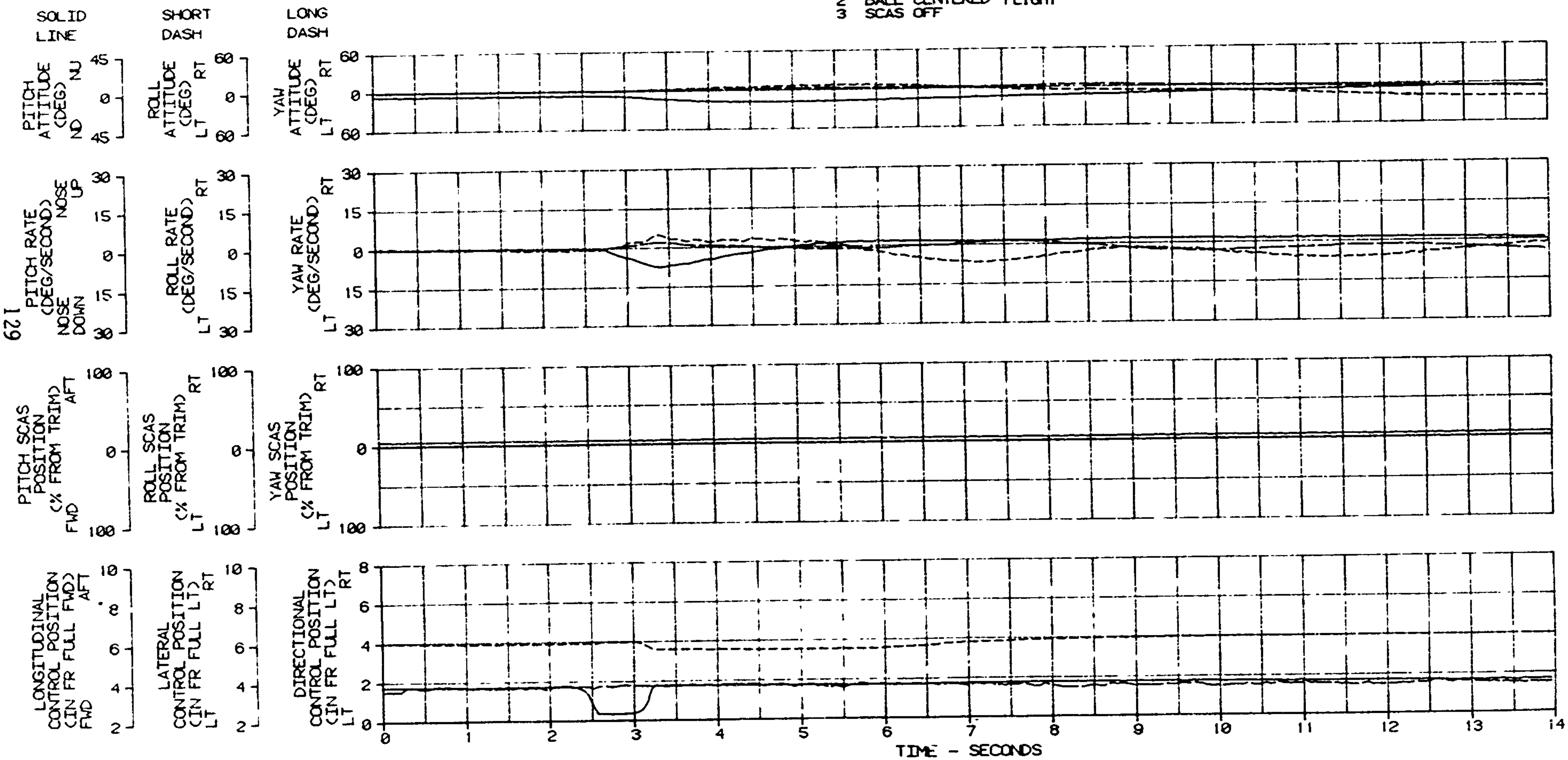


FIGURE 69

LEFT LATERAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9320 | 196 5(MID) | 1 7(LT) | 7800 | 15.5 | 323 | 86 | LEVEL |

NOTES 1. HELLFIRE/TOW CONFIGURATION
2. BALL CENTERED FLIGHT
3 SCAS OFF

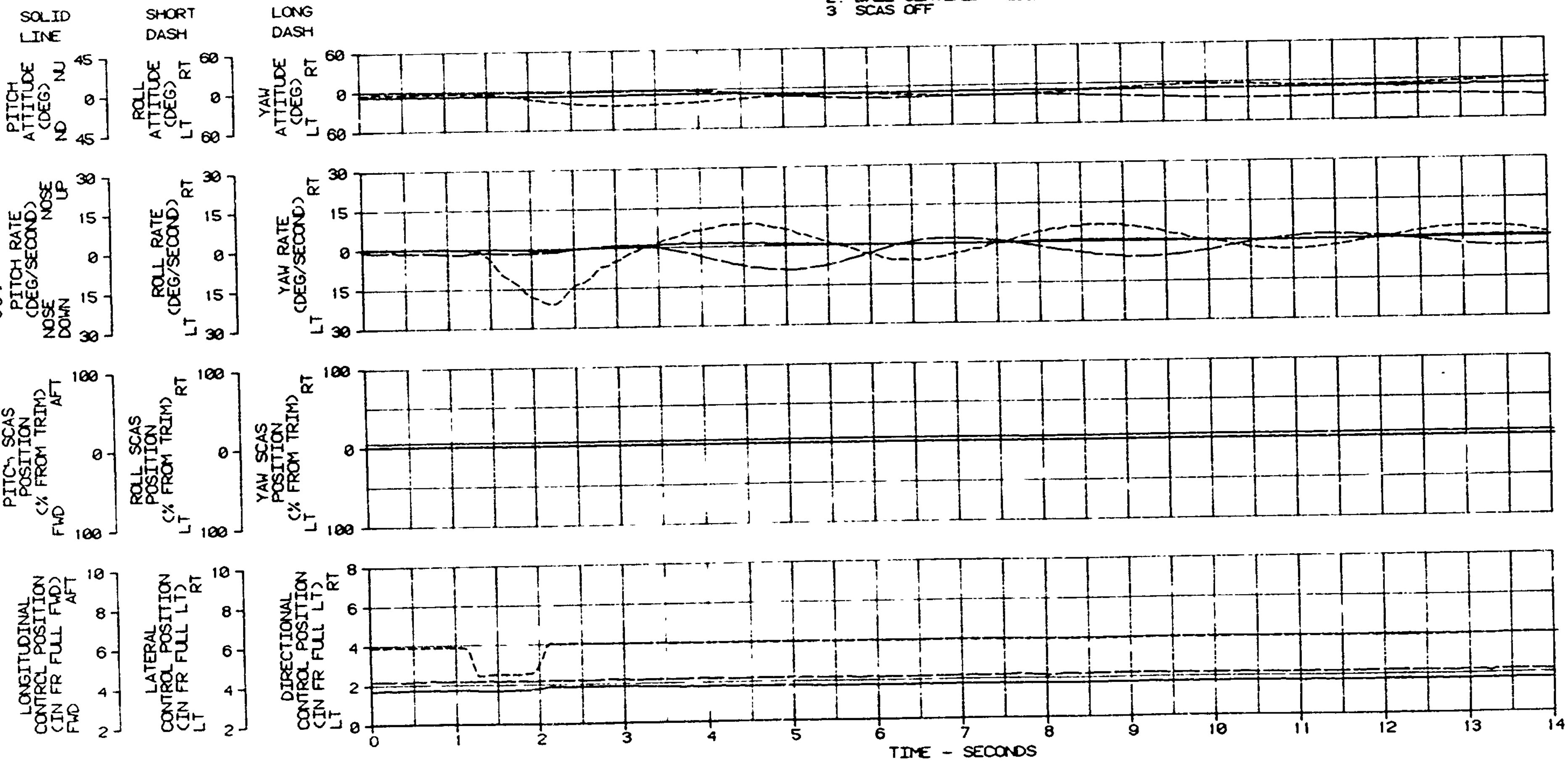


FIGURE 70

AFT LONGITUDINAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9640 | 196 9(MID) | 1 6(LT) | 8010 | 23.0 | 321 | 106 | LEVEL |

NOTES 1 STINGER/HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

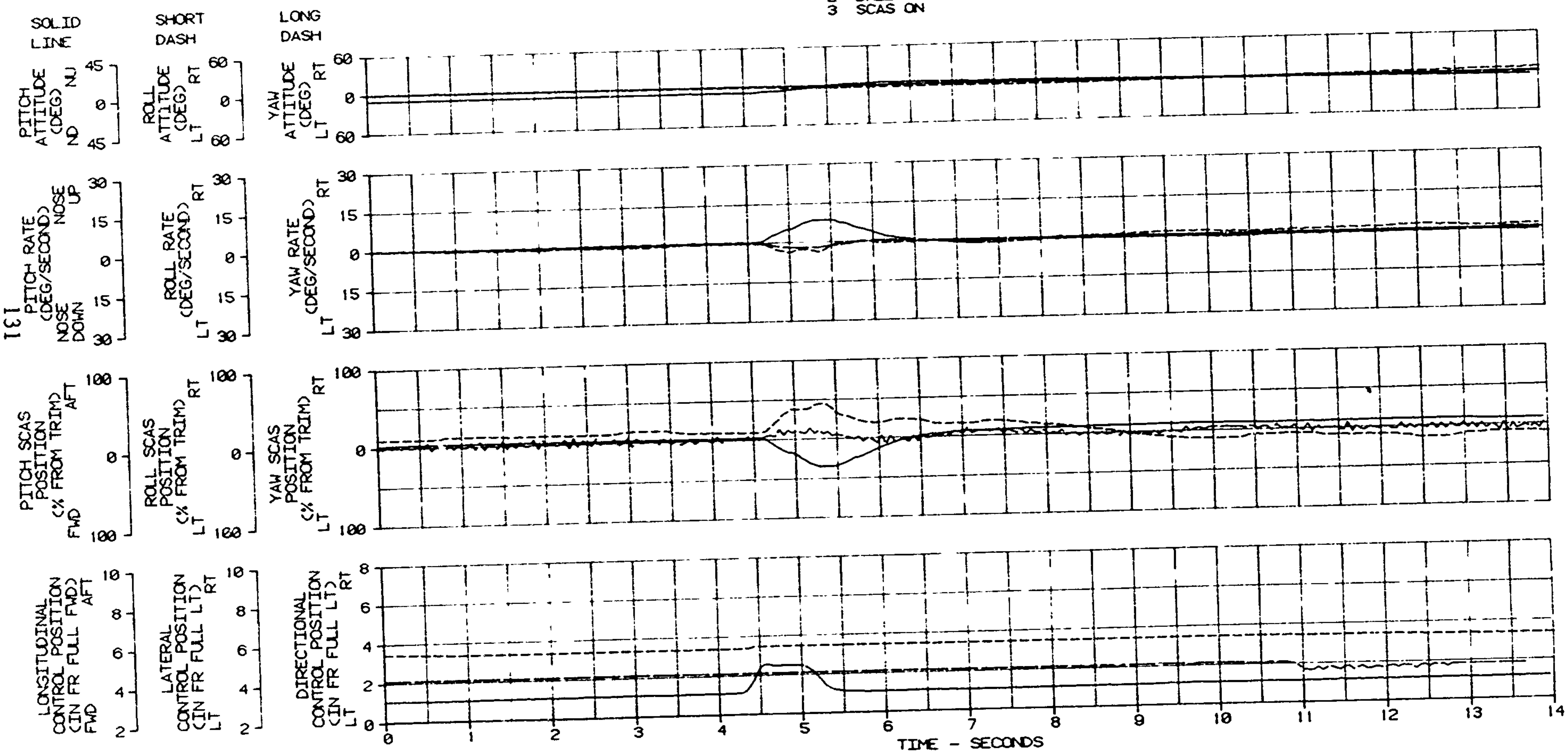


FIGURE 71

LEFT LATERAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9570 | 196.9(MID) | 1 6(LT) | 8160 | 23 0 | 321 | 104 | LEVEL |

NOTES 1. STINGER/HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

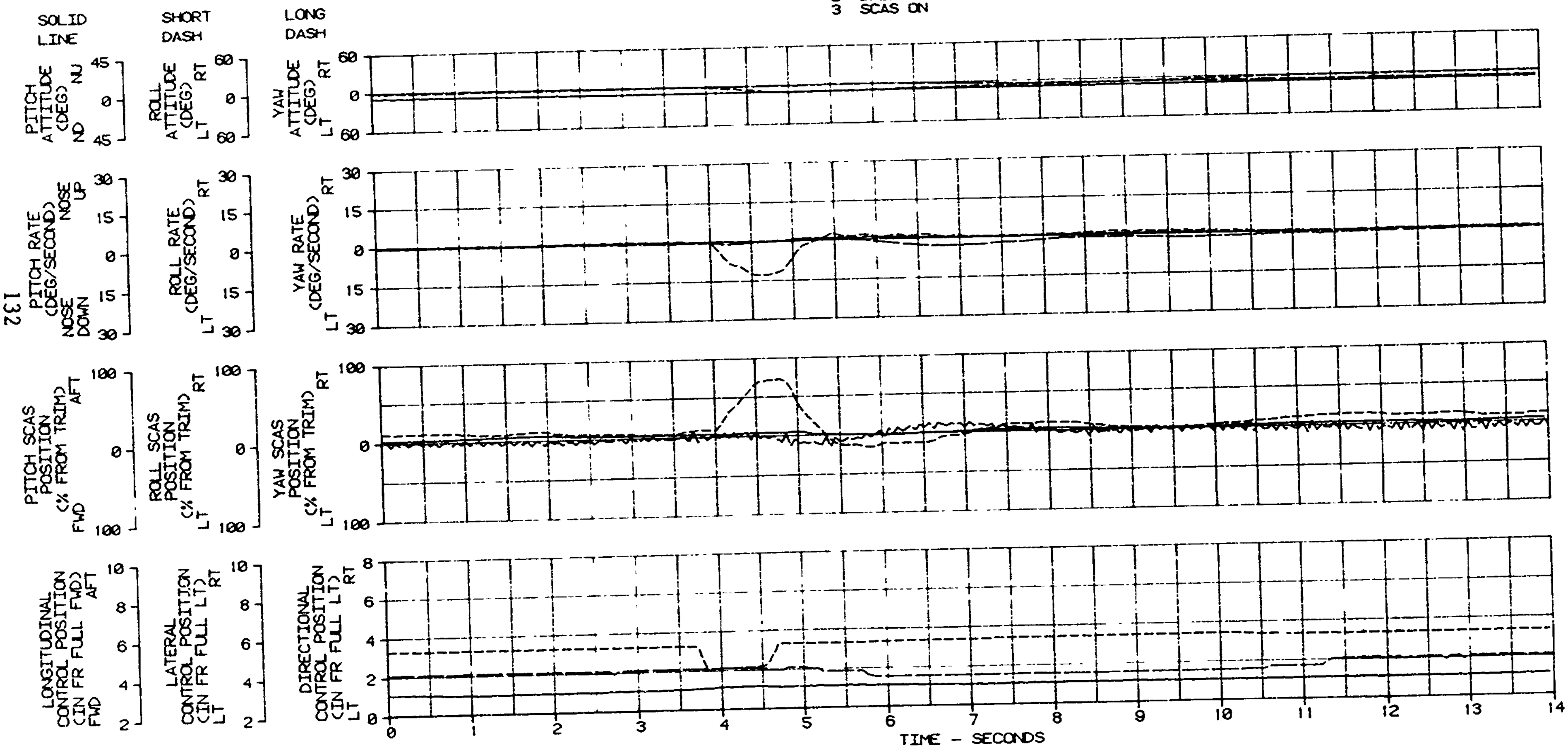


FIGURE 72

LEFT PEDAL PULSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9730 | 197 0(MID) | 1 5(LT) | 7940 | 23 0 | 322 | 65 | LEVEL |

NOTES
1 STINGER/HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

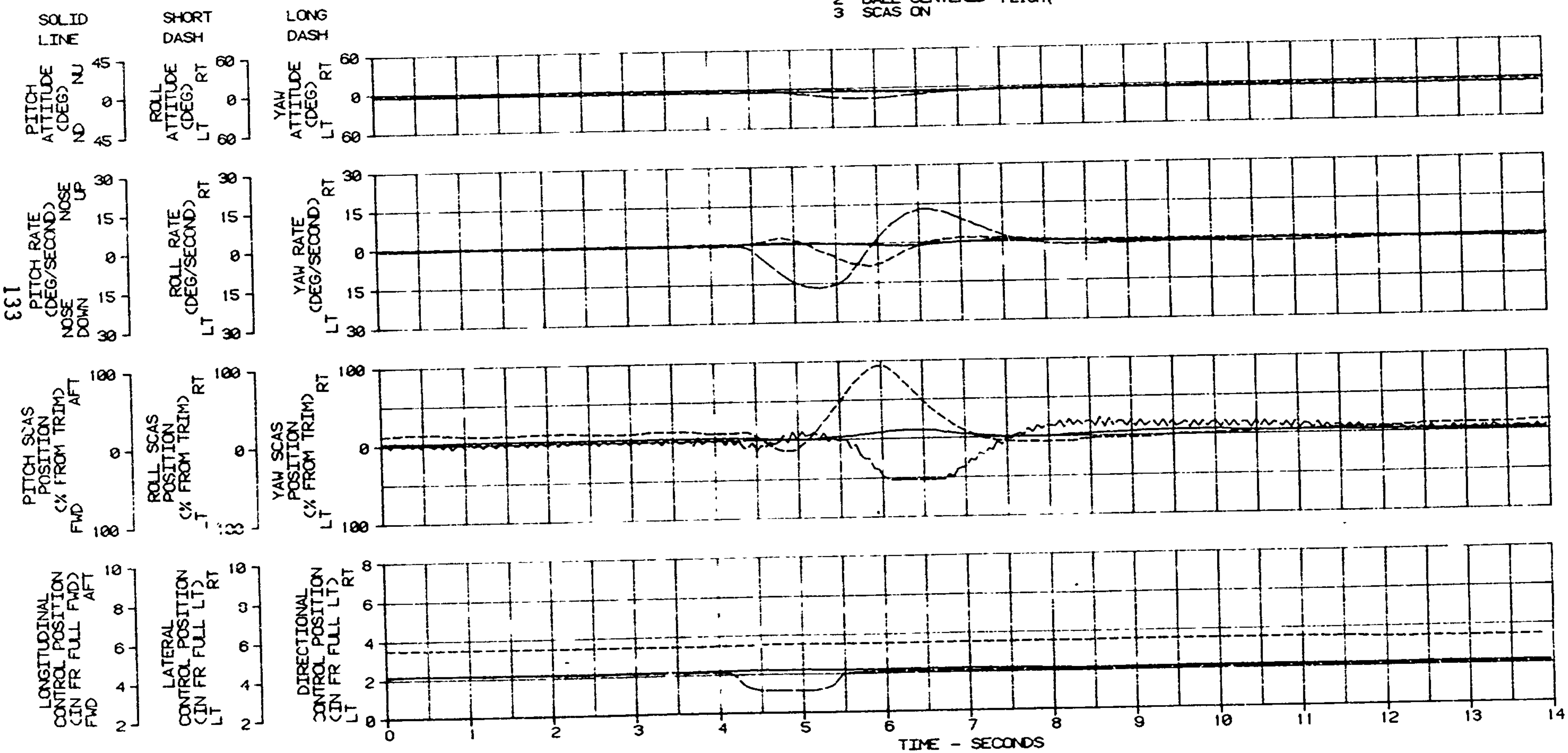


FIGURE 73

LONG TERM RESPONSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9170 | 196.9(MID) | 1 5(LT) | 7540 | 15 5 | 323 | 66 | LEVEL |

NOTES
1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

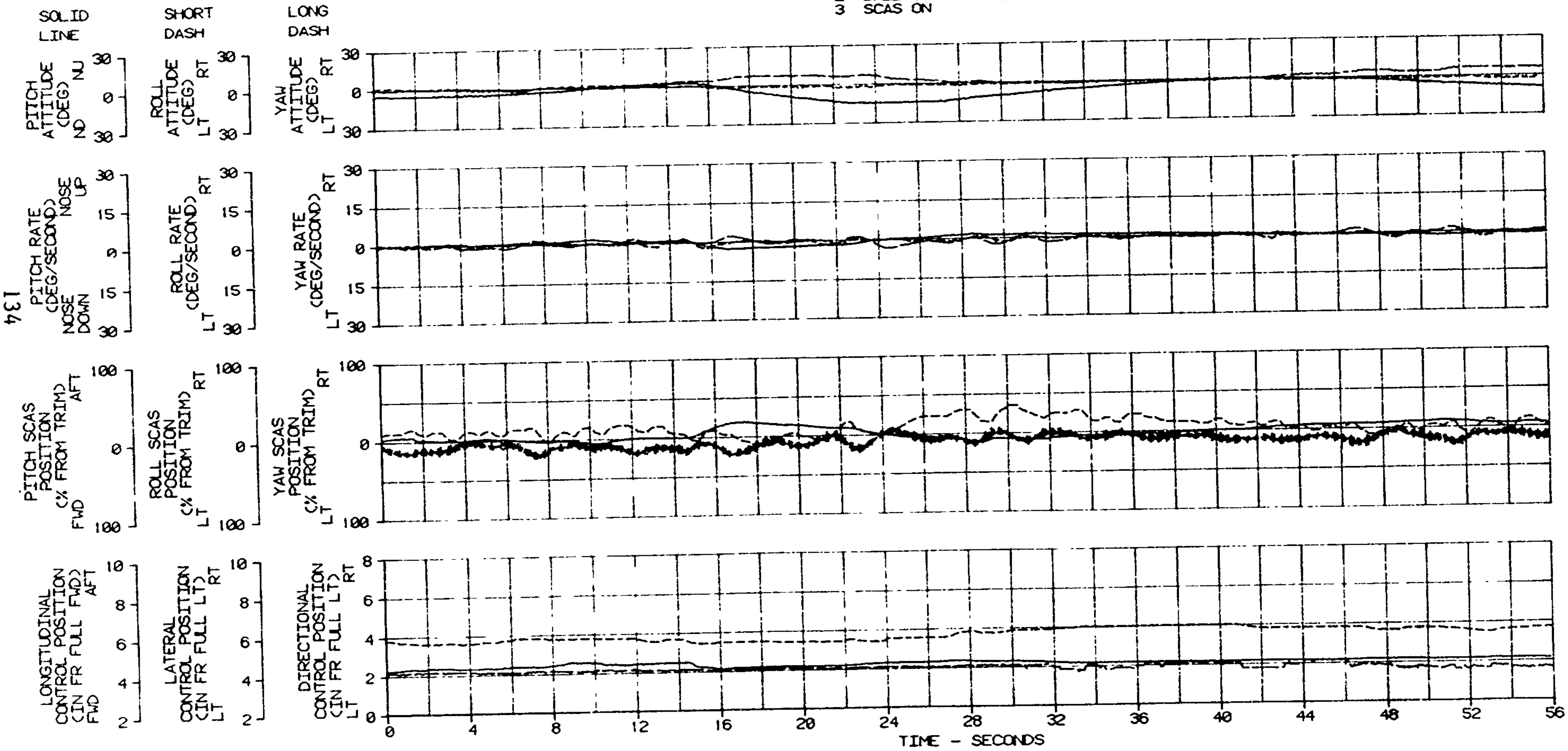


FIGURE 74

LONG TERM RESPONSE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 943 | 196 9(MID) | 2 7(LT) | 8000 | 20.0 | 324 | 86 | LEVEL |

NOTES 1 HELLFIRE CONFIGURATION
2 BALL CENTERED FLIGHT
3. SCAS OFF

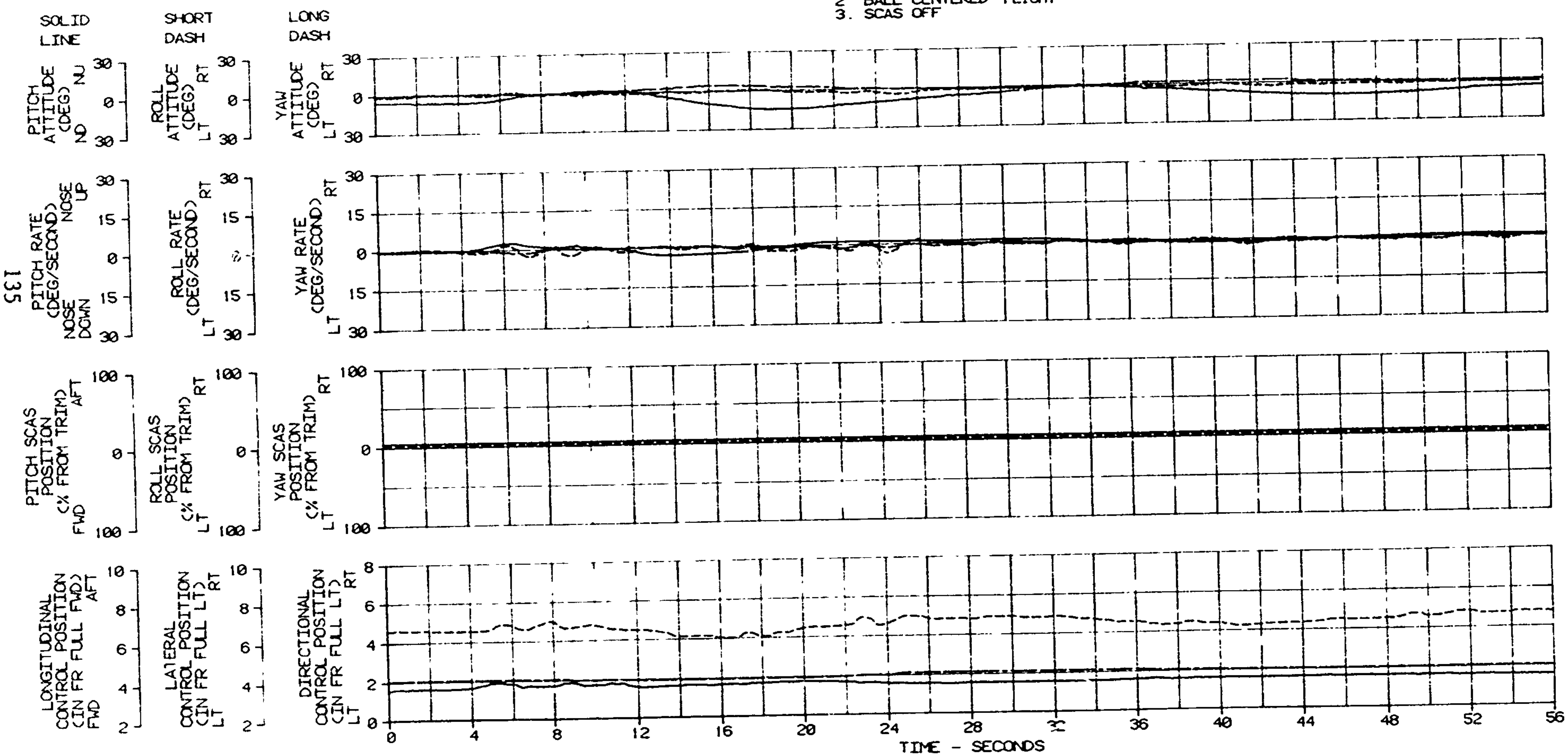


FIGURE 75

LOW SPEED FLIGHT 90 DEG. AZIMUTH

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9680 | 196.2(MID) | 2.7 LT | 4250 | 26.0 | 321 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SCAS ON
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

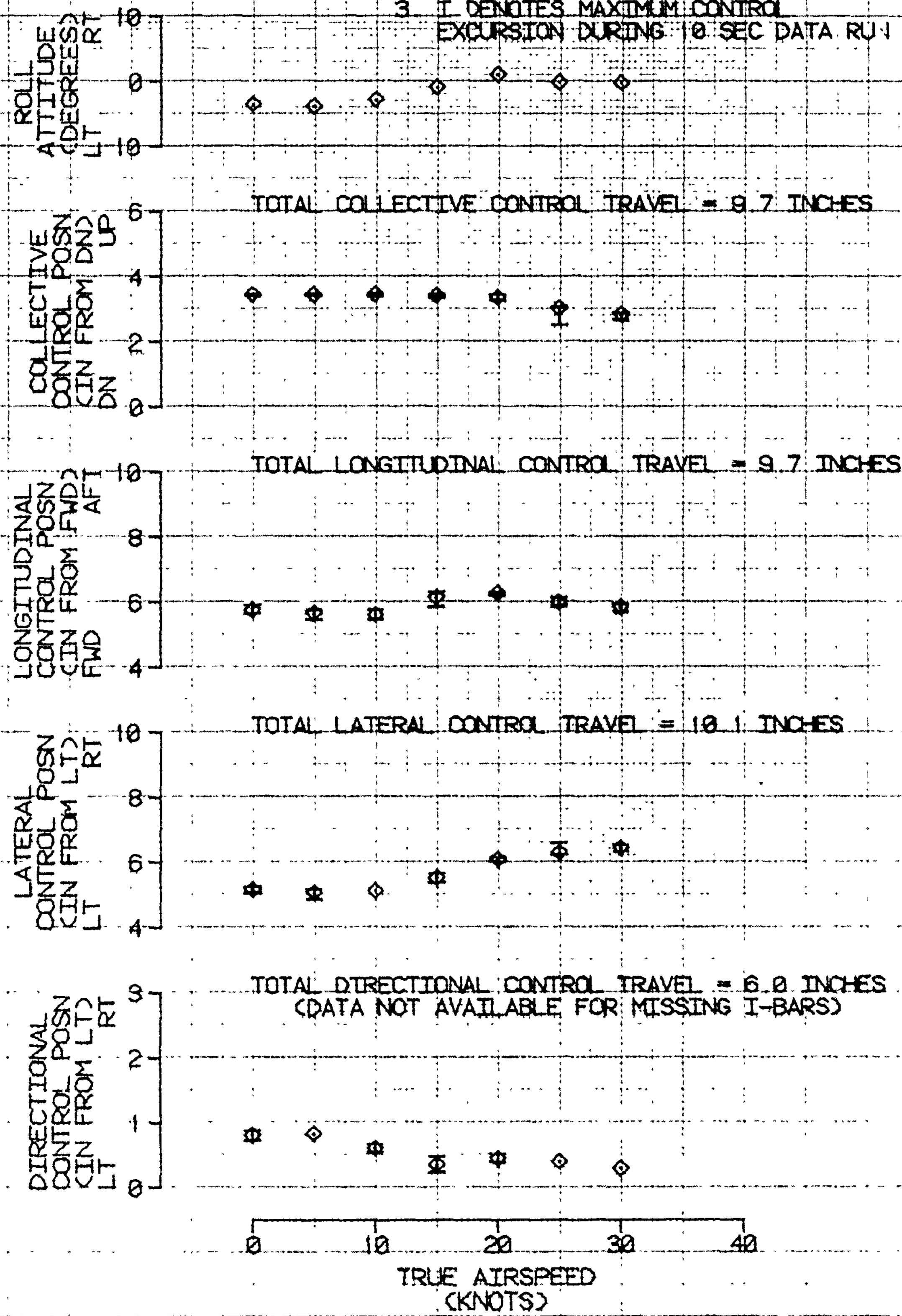


FIGURE 76
LOW SPEED REARWARD FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9570 | 196.2(MID) | 2.7 LT | 4310 | 26.5 | 321 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SCAS ON
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

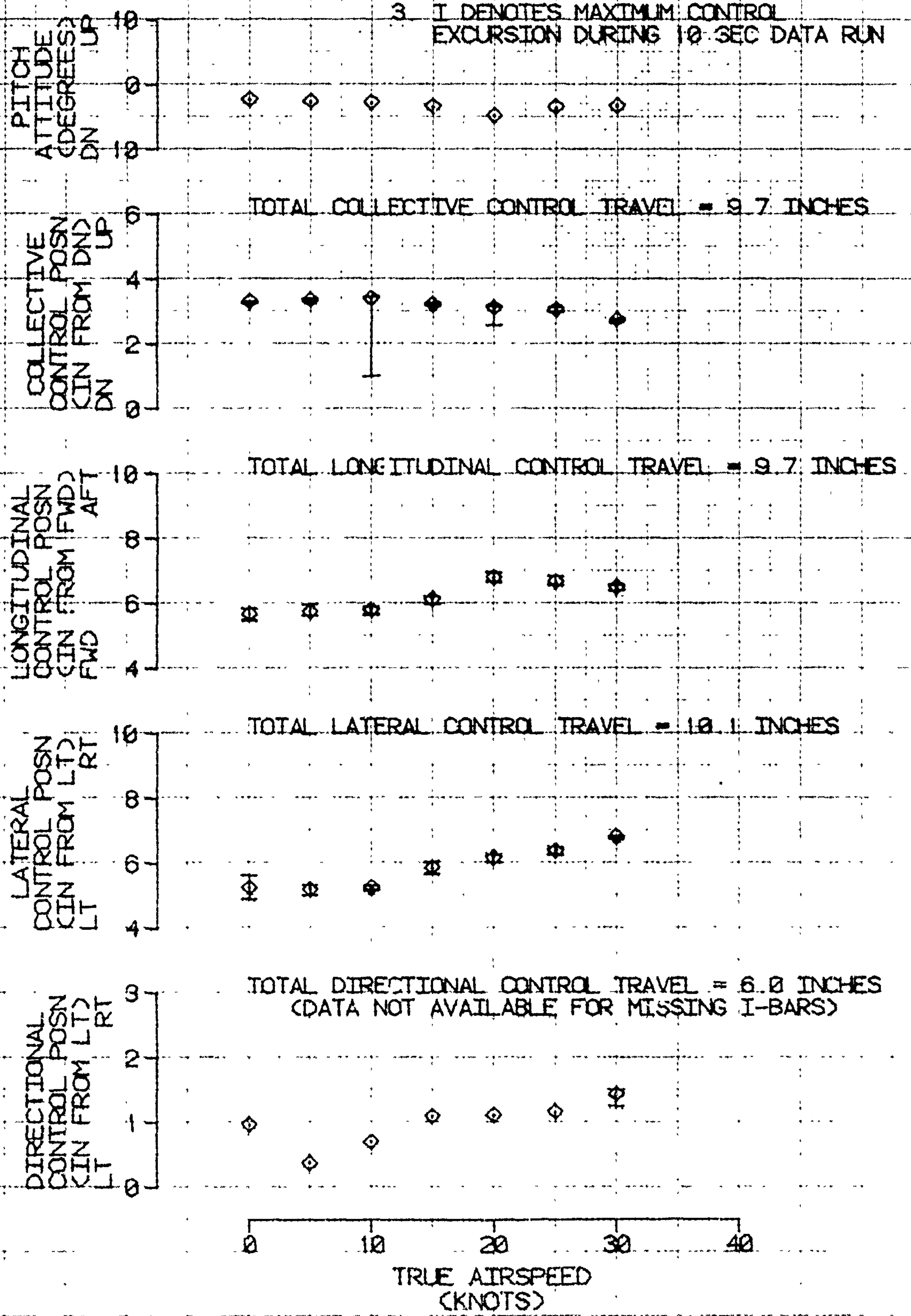


FIGURE 77
LOW SPEED FLIGHT 90 DEG. AZIMUTH
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9430 | 196.2(MID) | 2.7 LT | 4360 | 27.0 | 321 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SCAS OFF
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

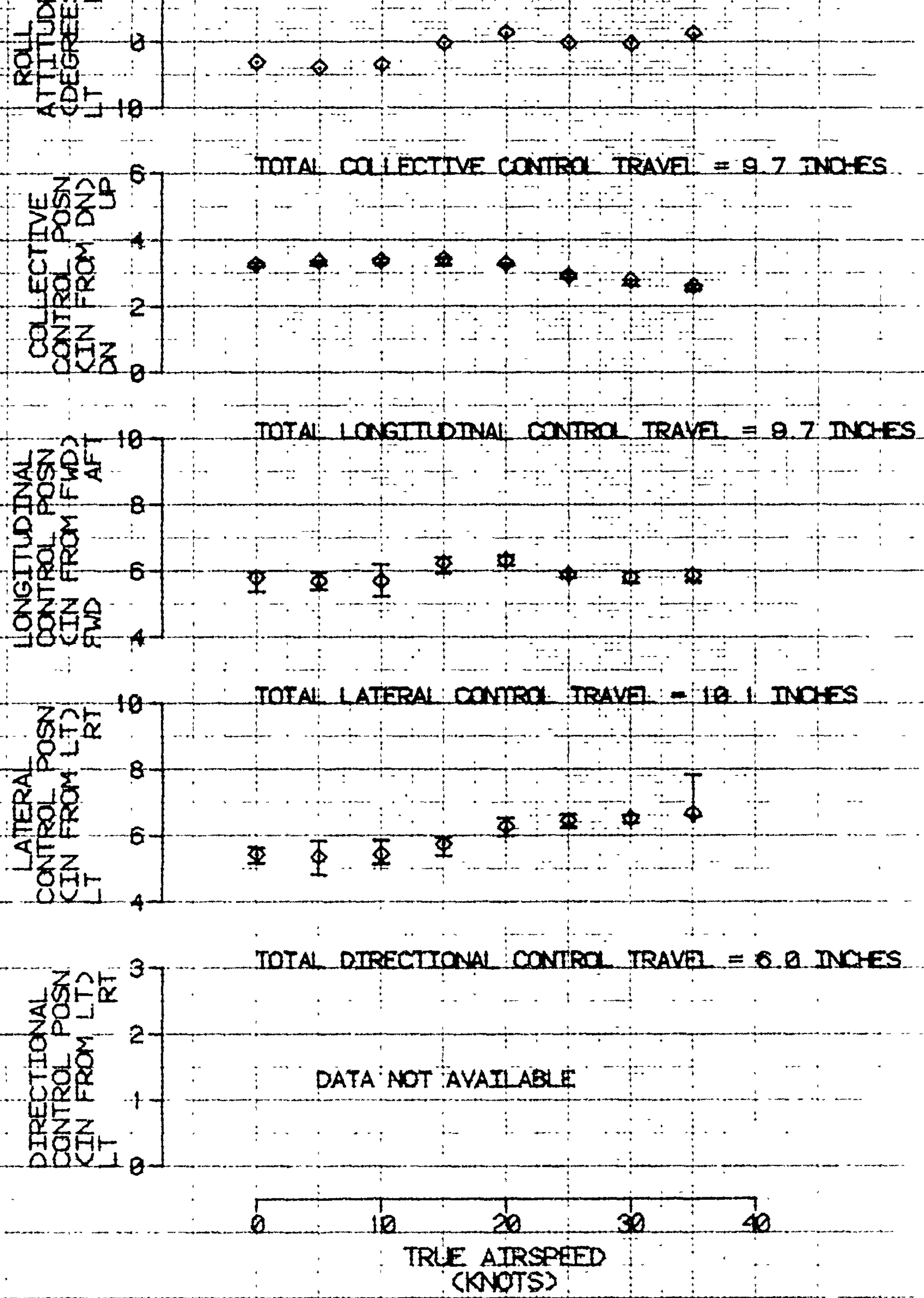


FIGURE 78
LOW SPEED REARWARD FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9320 | 196.2(MID) | 2.7 LT | 4460 | 28.0 | 321 | LEVEL |

NOTES: 1. HELLFIRE CONFIGURATION
2. SCAS OFF
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

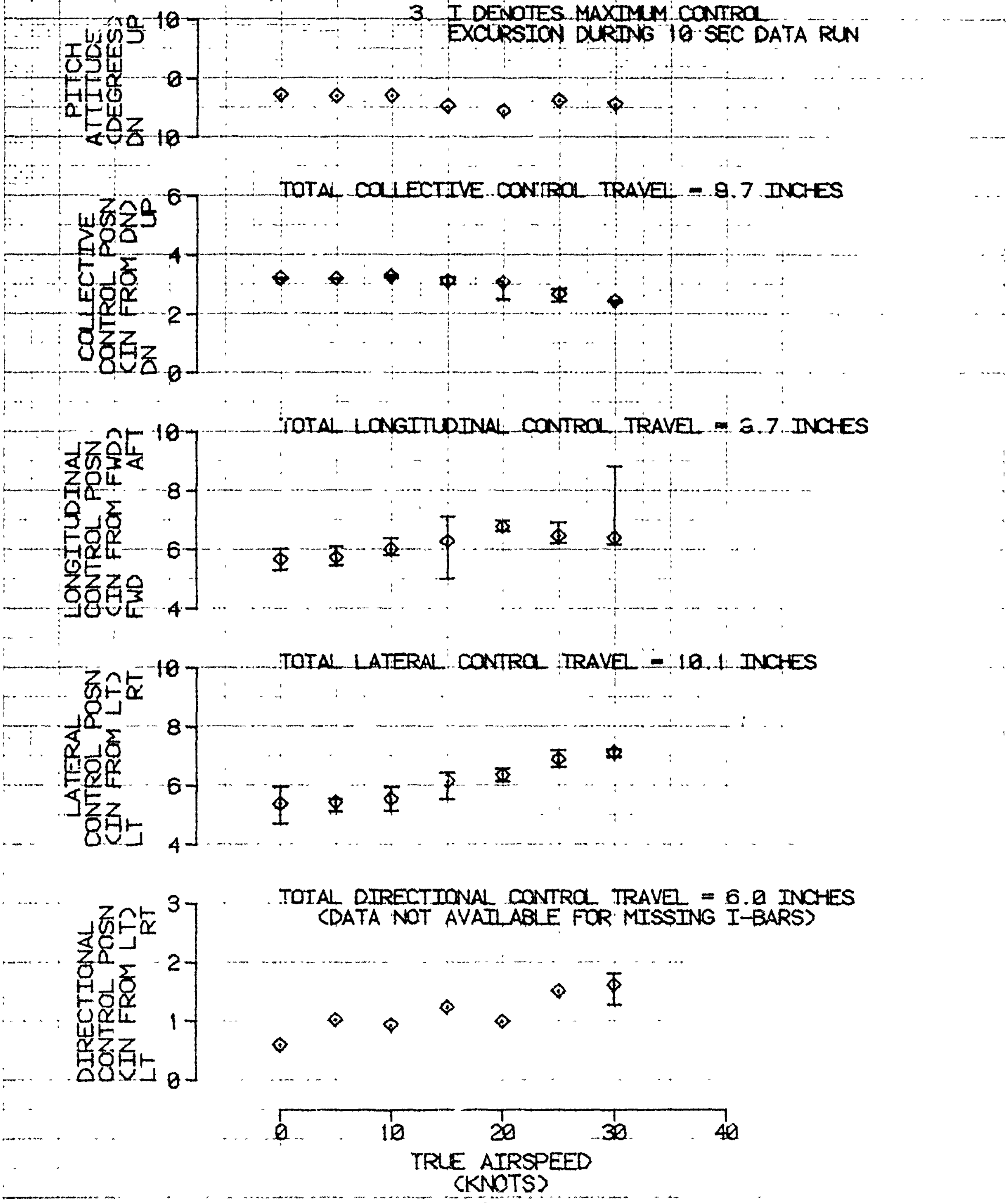


FIGURE 79

LOW SPEED FLIGHT 90 DEG AZIMUTH

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9680 | 196.2(MID) | 1.6 LT | 4450 | 28.0 | 321 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SCAS ON
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

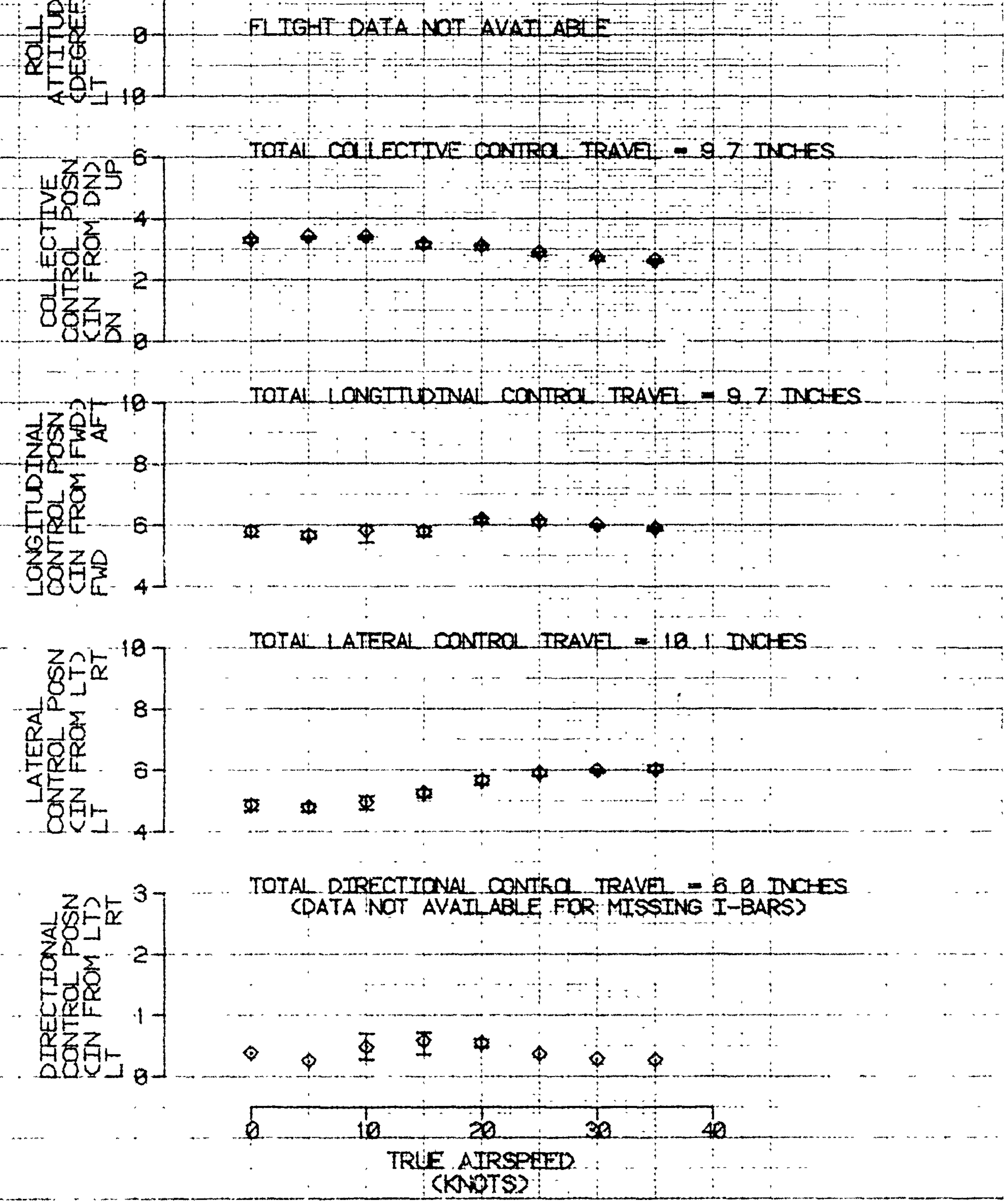
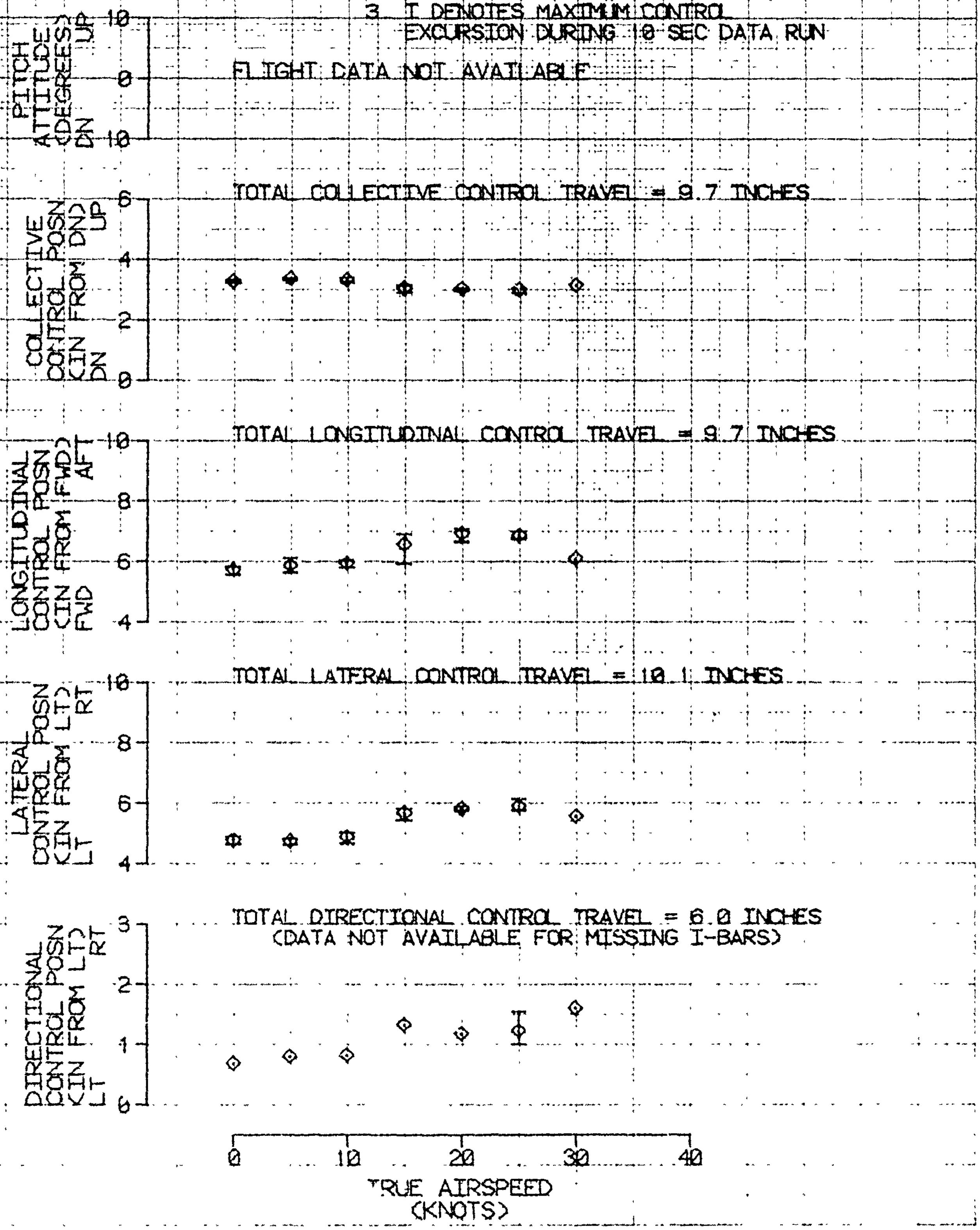


FIGURE 80
LOW SPEED REARWARD FLIGHT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9610 | 196.2(MID) | 1.6 LT | 4480 | 28.0 | 321 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SCAS ON
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN



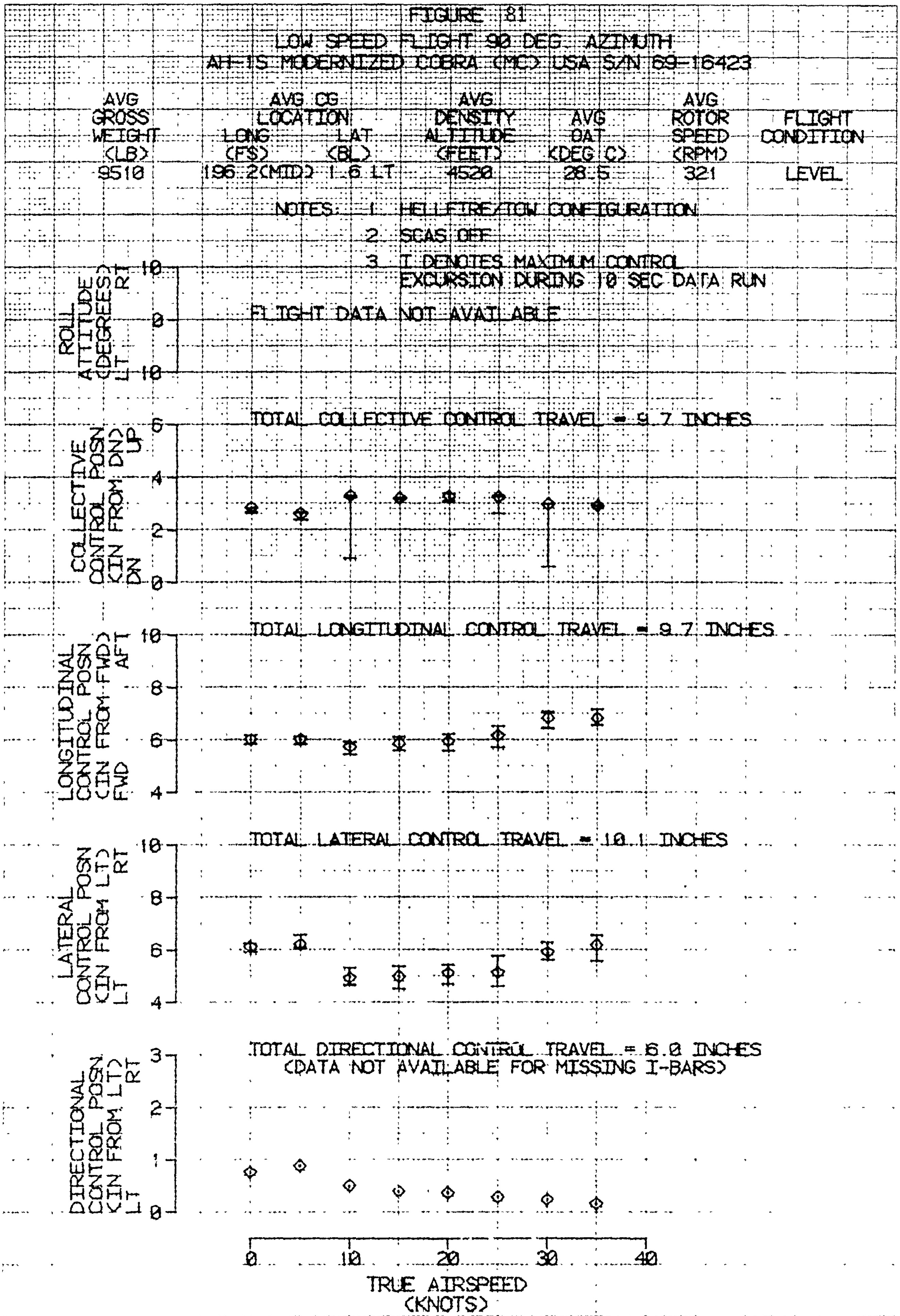


FIGURE 81
LOW SPEED FLIGHT 90 DEG AZIMUTH
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9510
AVG CG LOCATION LONG (FS) 196.2(MID) LAT (BL) 1.6 LT
AVG DENSITY ALTITUDE (FEET) 4520
AVG OAT (DEG C) 28.5
AVG ROTOR SPEED (RPM) 321
FLIGHT CONDITION LEVEL
NOTES: 1 HELLFIRE/TOW CONFIGURATION
2 SCAS OFF
3 I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN
ROLL ATTITUDE (DEGREES) LT RT
FLIGHT DATA NOT AVAILABLE
TOTAL COLLECTIVE CONTROL TRAVEL = 9.7 INCHES
COLLECTIVE CONTROL POSN (IN FROM DN) DN UP
TOTAL LONGITUDINAL CONTROL TRAVEL = 9.7 INCHES
LONGITUDINAL CONTROL POSN (IN FROM FWD) FWD AFT
TOTAL LATERAL CONTROL TRAVEL = 10.1 INCHES
LATERAL CONTROL POSN (IN FROM LT) LT RT
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.0 INCHES
(DATA NOT AVAILABLE FOR MISSING I-BARS)
DIRECTIONAL CONTROL POSN (IN FROM LT) LT RT
TRUE AIRSPEED (KNOTS)

FIGURE 82

LOW SPEED REARWARD FLIGHT

AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FEET) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9490 | 196.2(MID) | 1.6 LT | 4610 | 29.5 | 321 | LEVEL |

NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. SCAS OFF
3. I DENOTES MAXIMUM CONTROL EXCURSION DURING 10 SEC DATA RUN

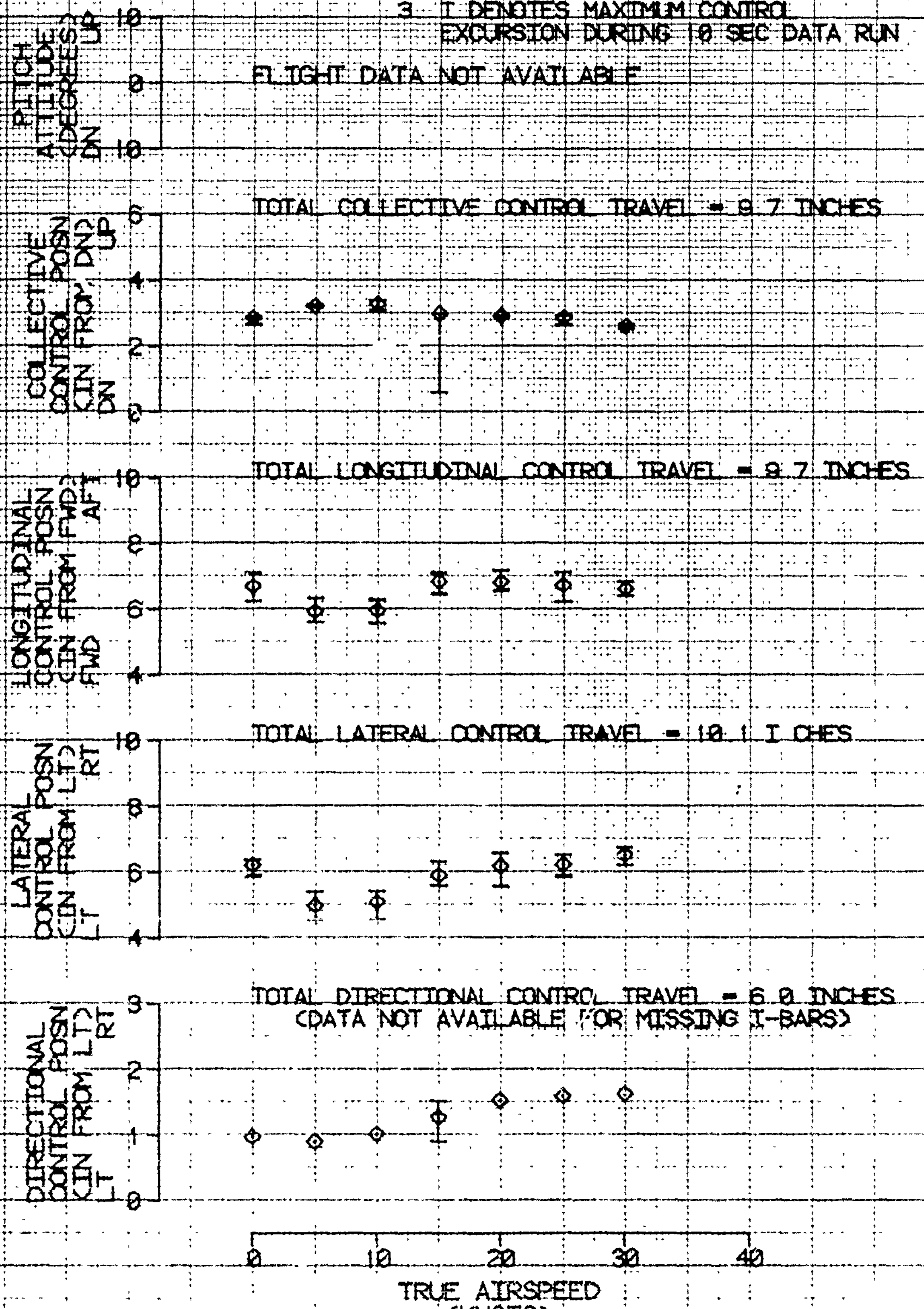


FIGURE 83A

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 9920 | 196.0(MID) | 2.6(LT) | 7680 | 21.0 | 325 | 122 | 58 |

NOTES
1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

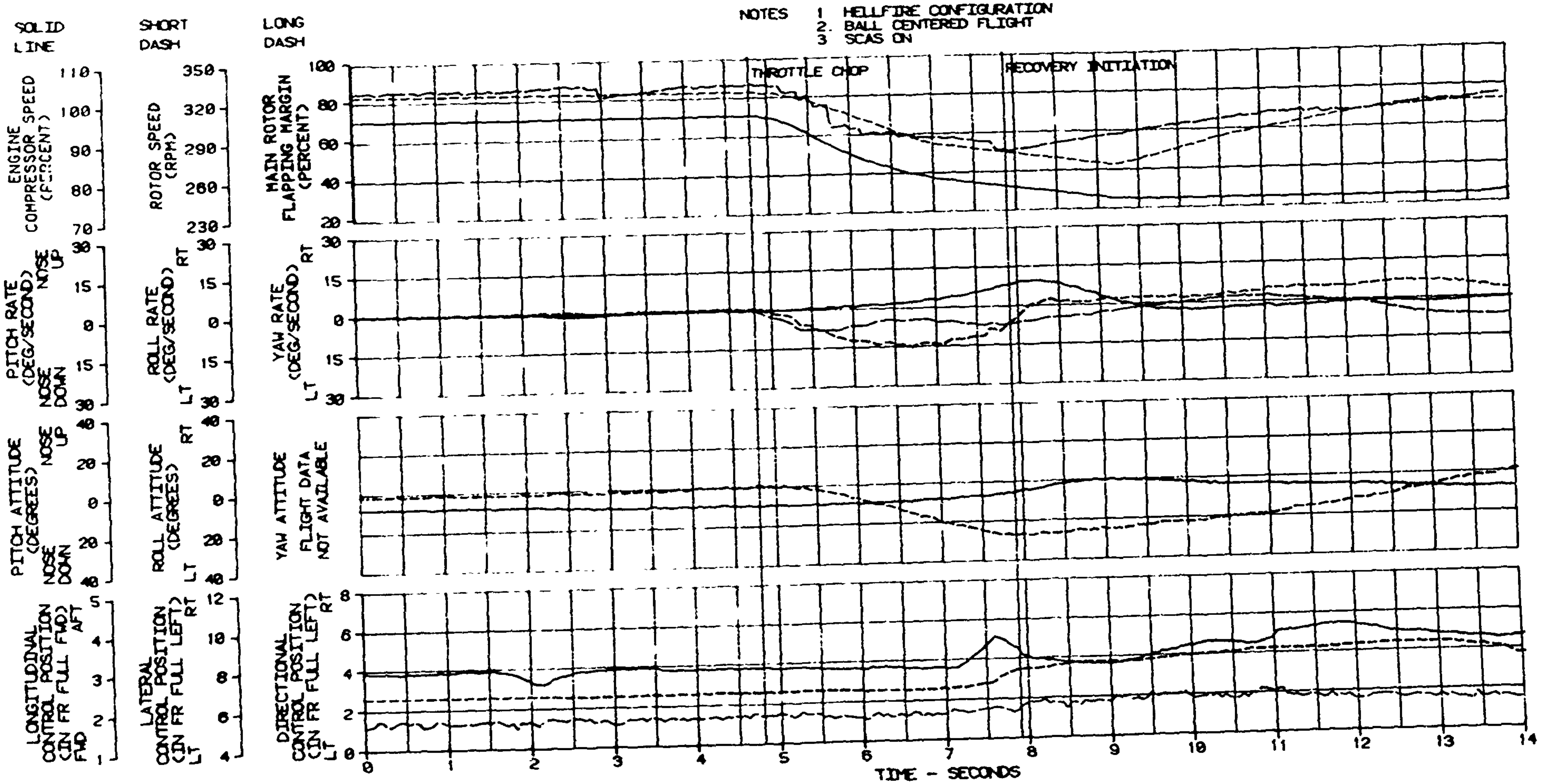


FIGURE 83B

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 9910 | 196.0(MID) | 2.8(LT) | 7670 | 21.0 | 325 | 122 | 58 |

NOTES.
1. HELLFIRE CONFIGURATION
2. BALL CENTERED
3. SCAS ON

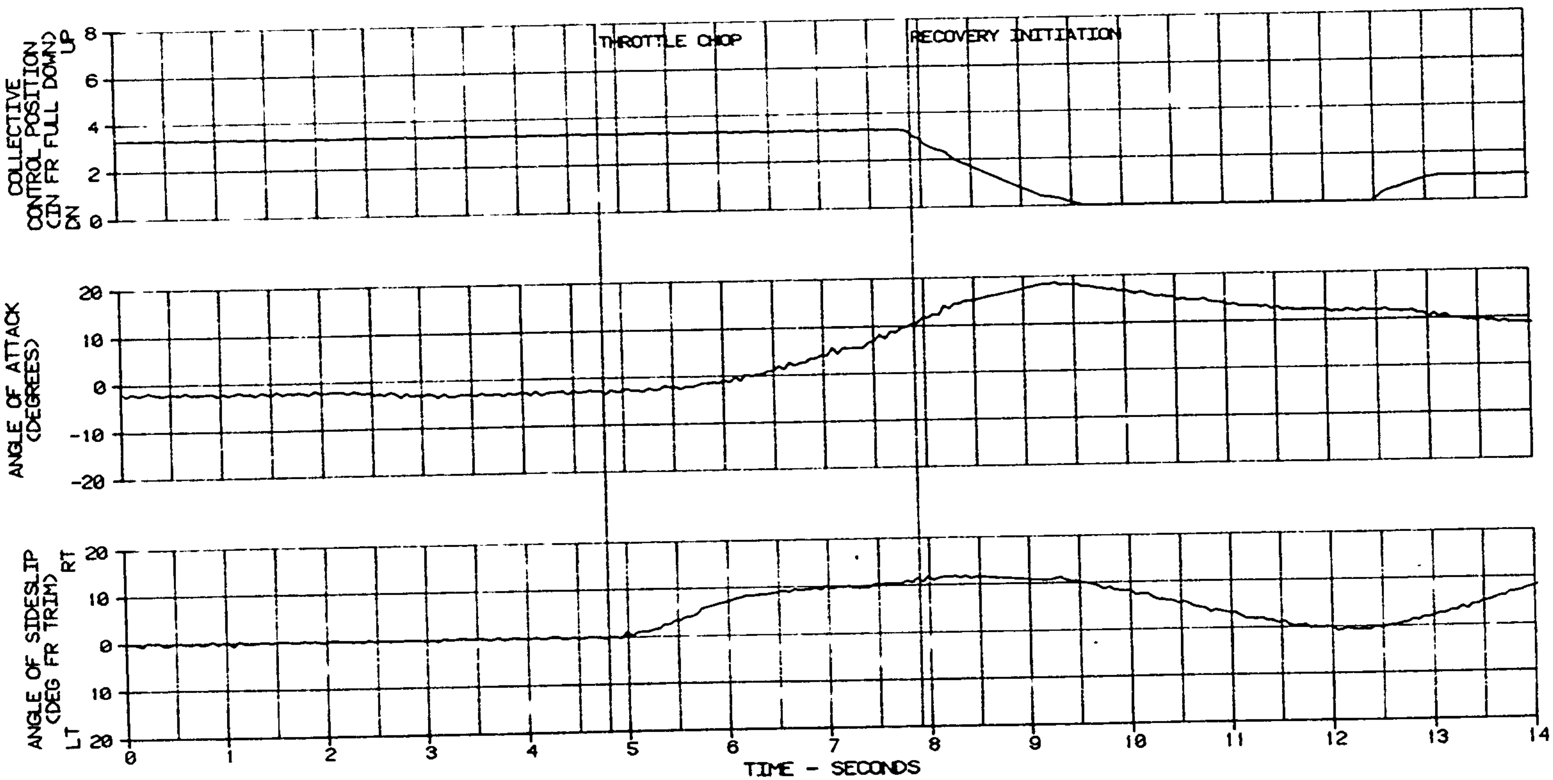


FIGURE 84A

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 9880 | 196 0(MID) | 2.6(LT) | 7780 | 21 0 | 324 | 123 | 71 |

NOTES: 1. HELLFIRE CONFIGURATION
2. BALL CENTERED FLIGHT
3. SCAS ON

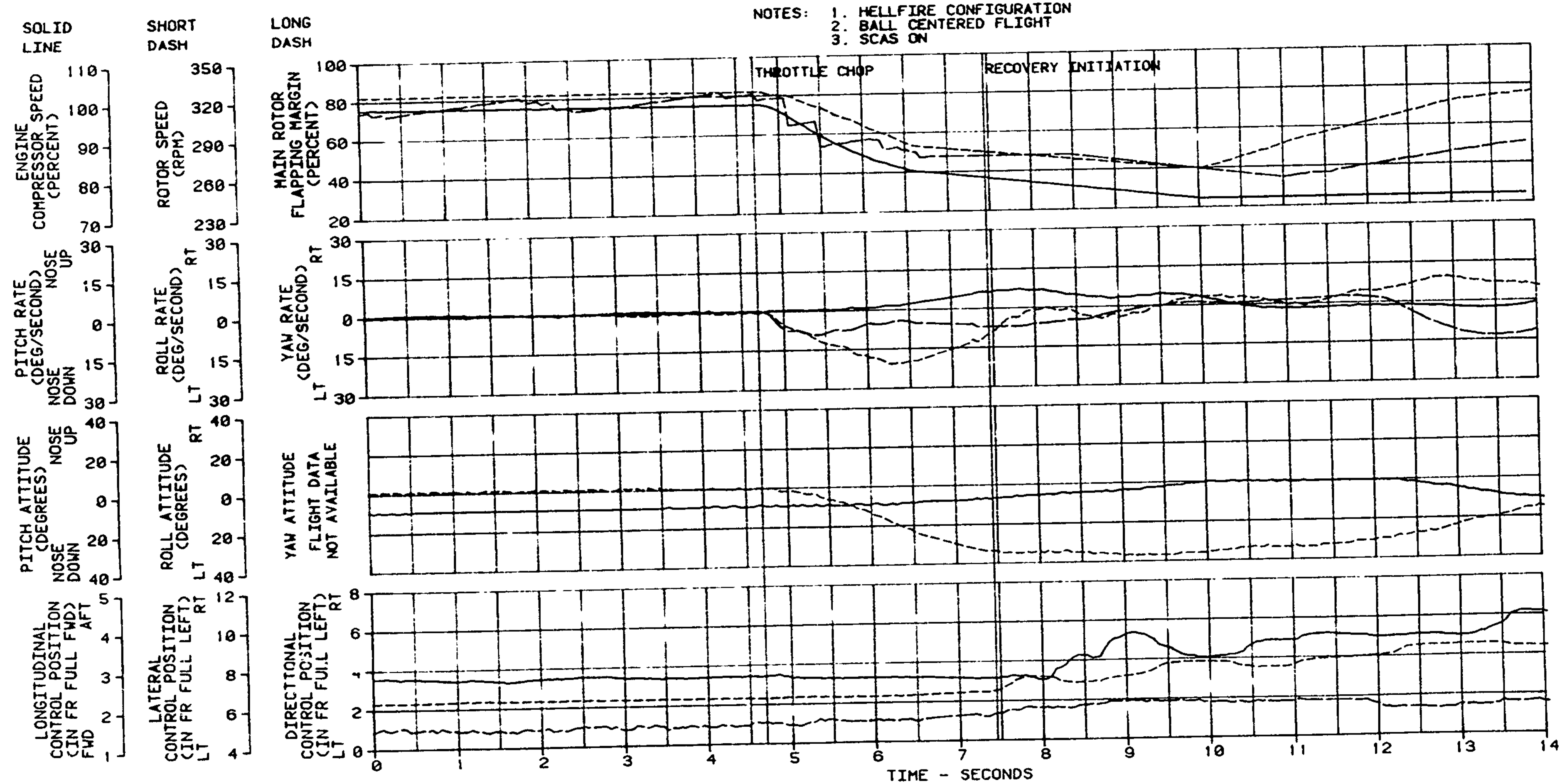


FIGURE 84B

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 9890 | 196 0(MID) | 2.6(LT) | 7780 | 21 0 | 324 | 123 | 71 |

NOTES 1 HELLFIRE CONFIGURATION
2. BALL CENTERED
3 SCAS ON

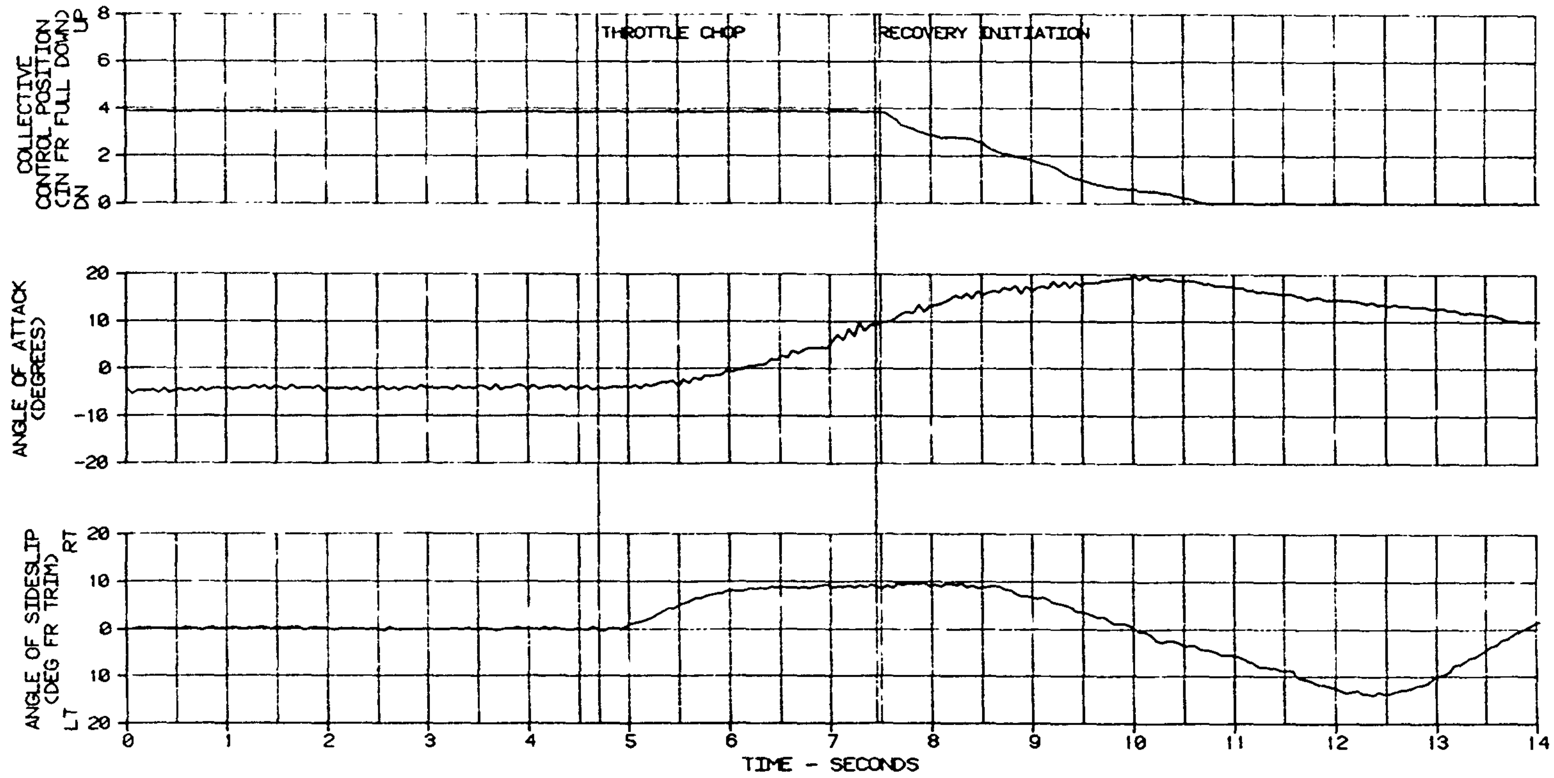


FIGURE 85A

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 10030 | 196 0(MID) | 1.6(LT) | 7590 | 19 5 | 327 | 124 | 48 |

NOTES 1. HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3. SCAS ON

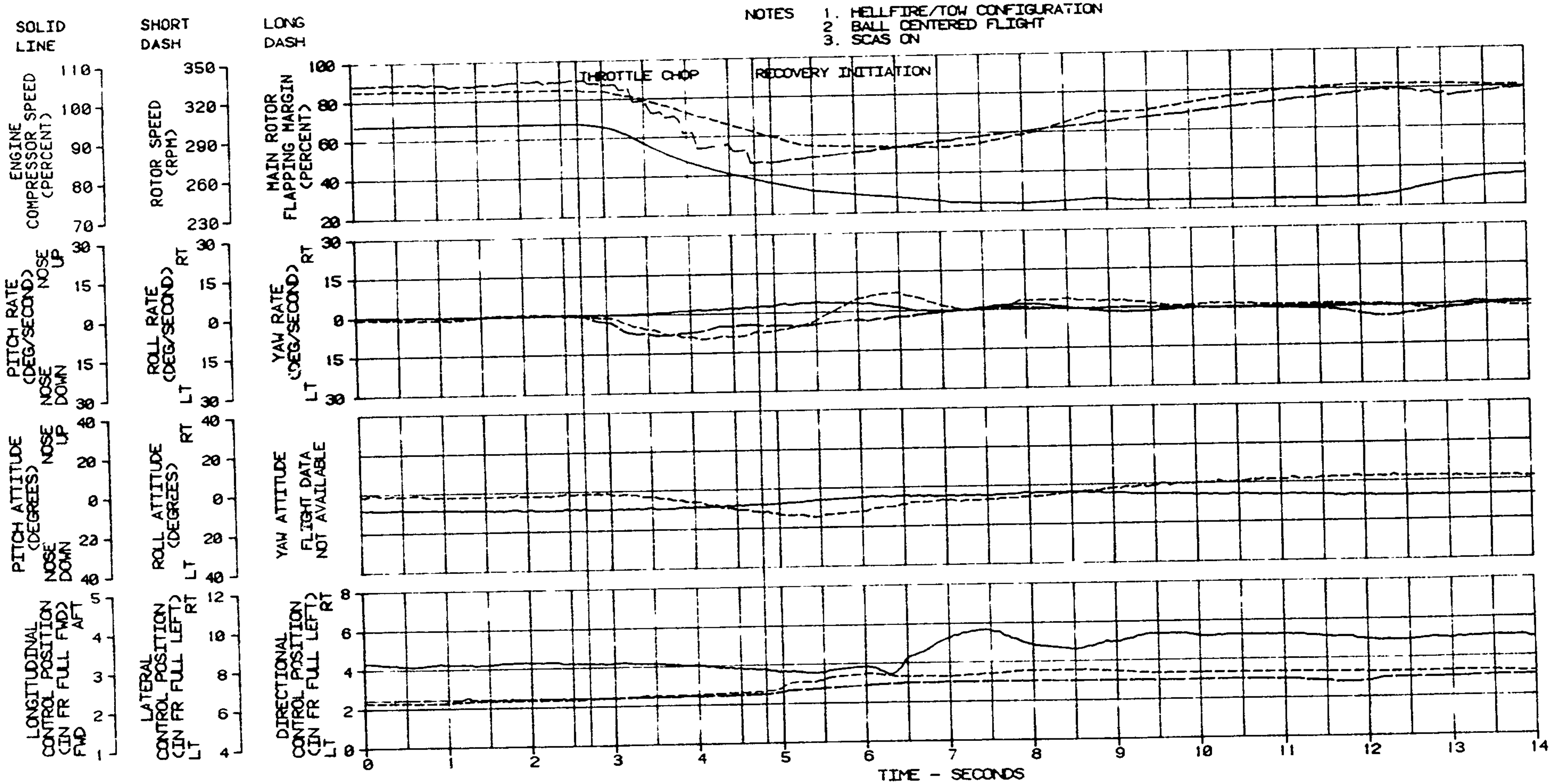


FIGURE 85B

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 10030 | 196 0(MID) | 1 6(LT) | 7590 | 19.5 | 327 | 124 | 48 |

NOTES: 1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3. SCAS ON

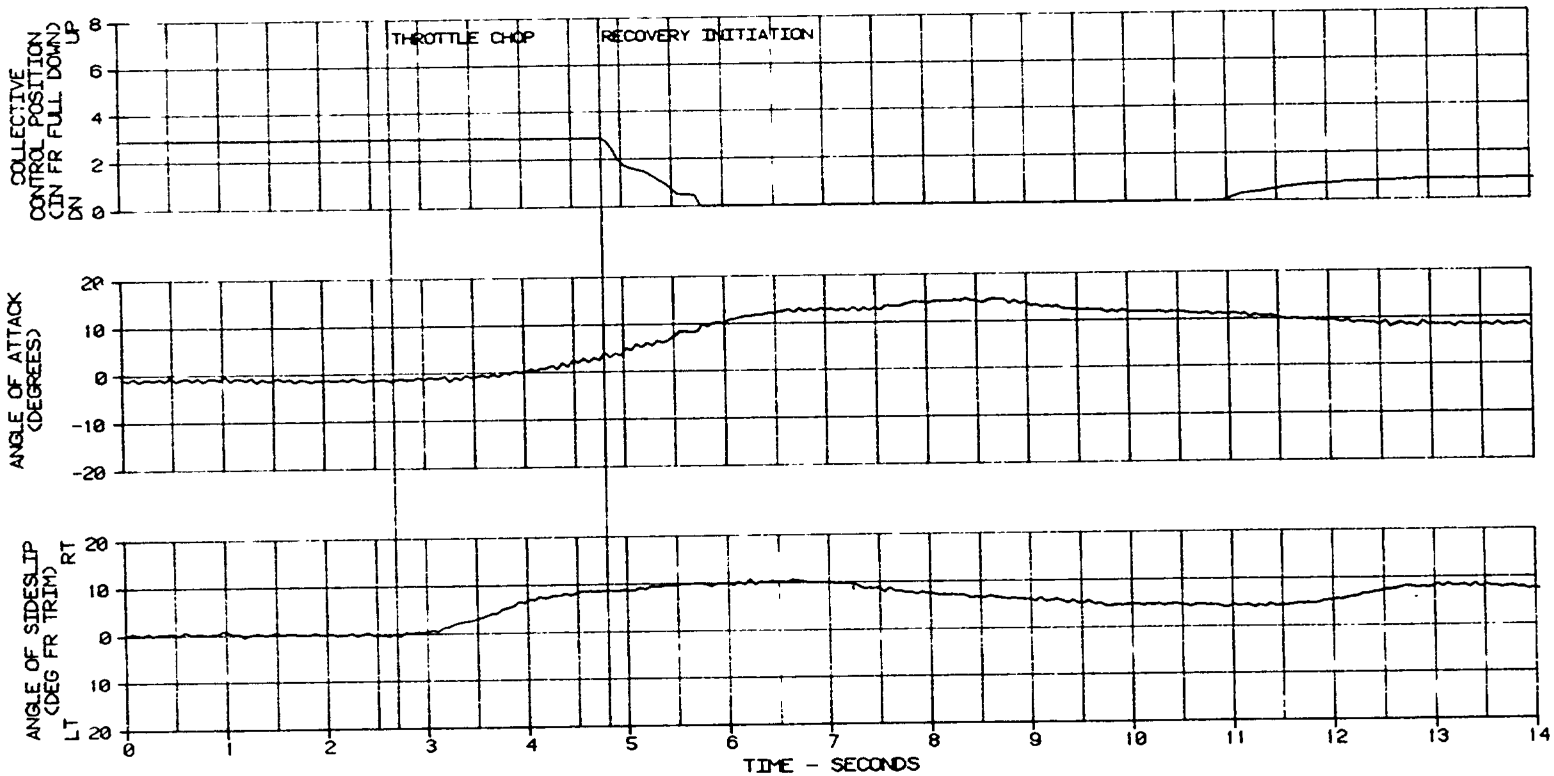


FIGURE 86A

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 10080 | 196.0(MID) | 1 6(LT) | 8330 | 19 0 | 325 | 125 | 87 |

NOTES. 1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

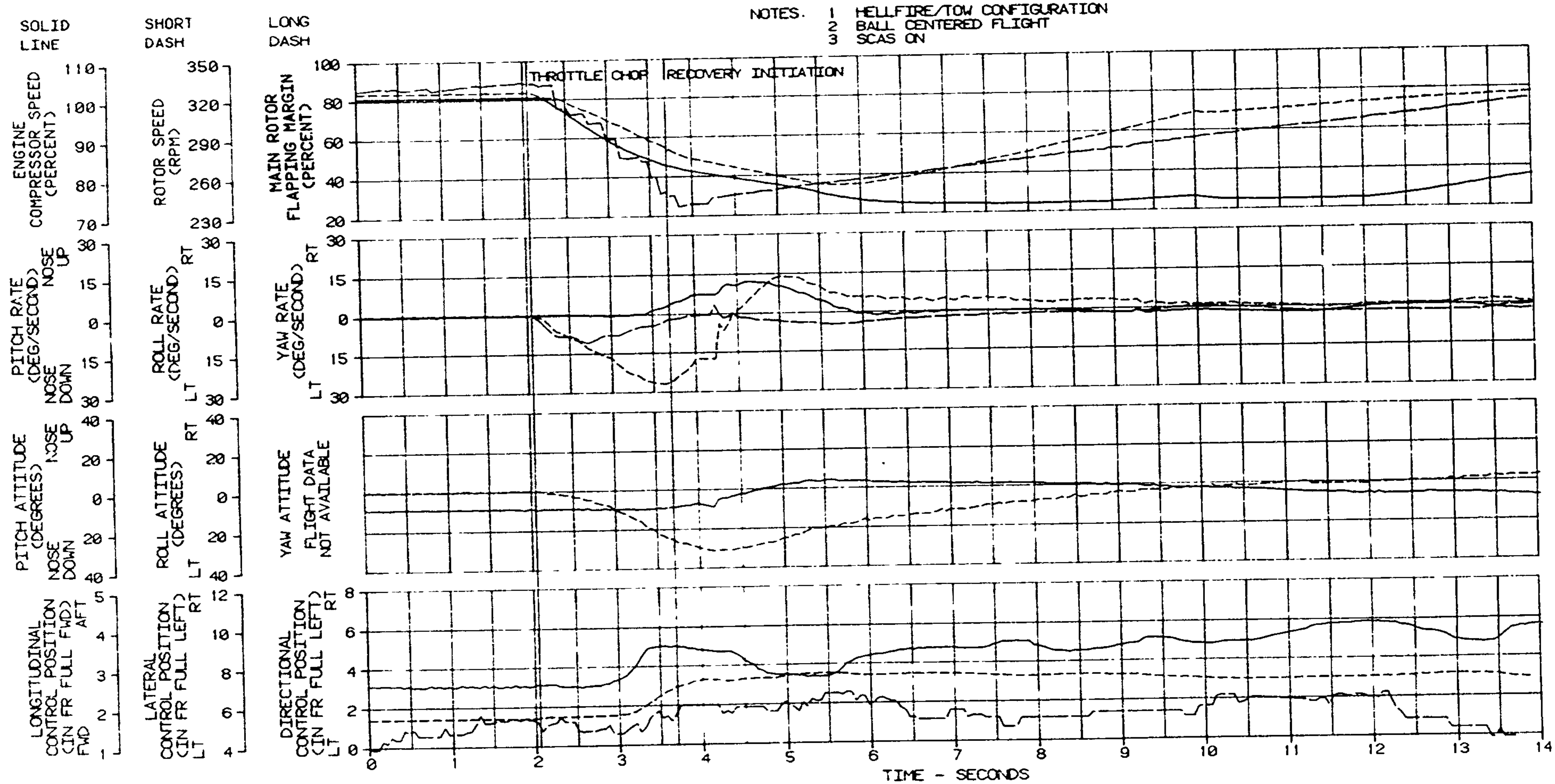


FIGURE 86B

SIMULATED ENGINE FAILURE
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | ENTRY ROTOR SPEED (RPM) | ENTRY CALIBRATED AIRSPEED (KT) | ENTRY ENGINE TORQUE (PERCENT) |
|---|---|---|---|---|---|---|---|
| 10080 | 196 0(MID) | 1 6(LT) | 8320 | 19 0 | 325 | 125 | 87 |

NOTES
1 HELLFIRE/TOW CONFIGURATION
2 BALL CENTERED FLIGHT
3 SCAS ON

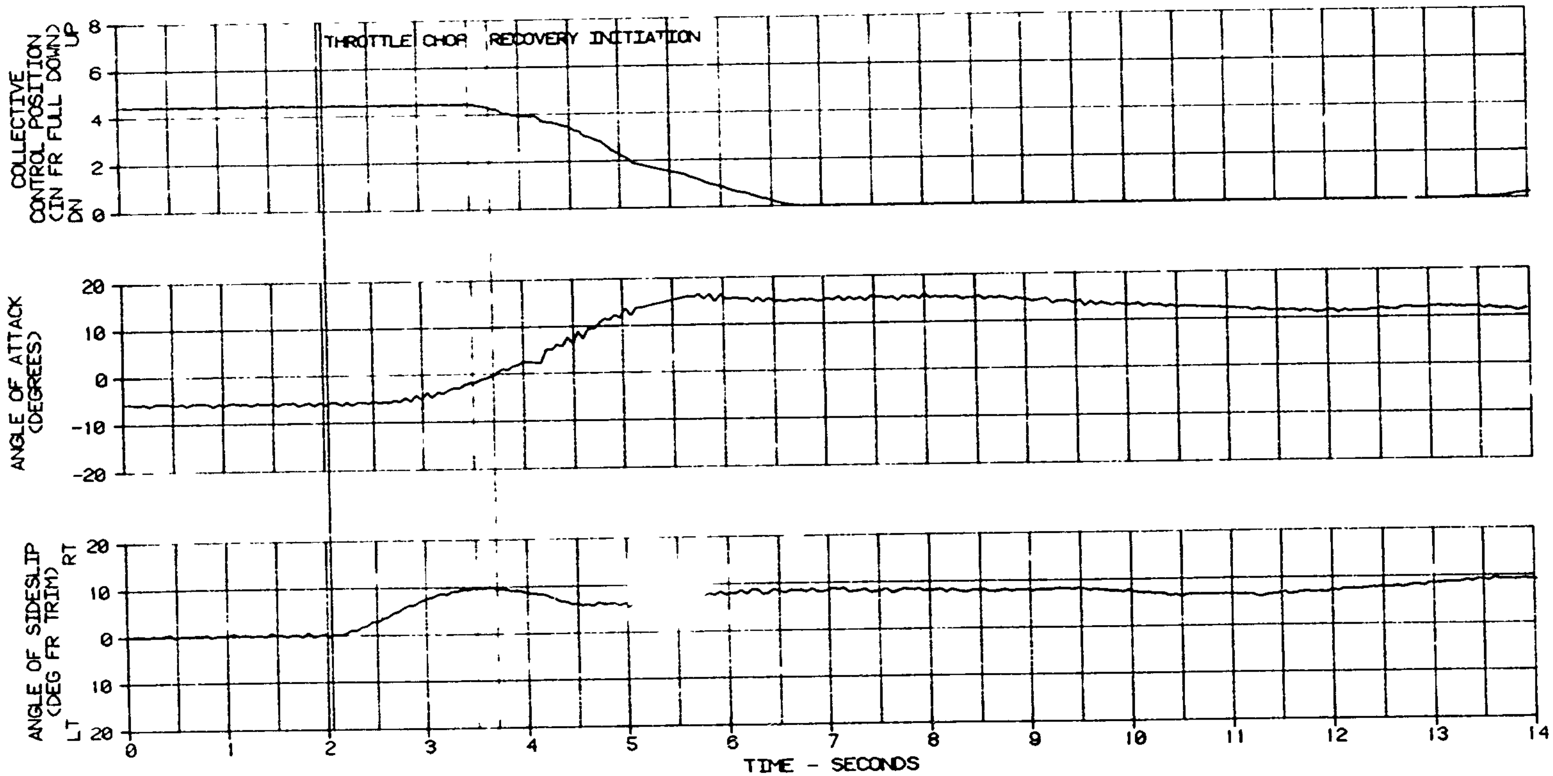


FIGURE 87

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9800 | 196 8(MID) | 2 6(LT) | 7020 | 21 0 | 322 | 128 | LEVEL |

NOTES 1 HELLFIRE CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

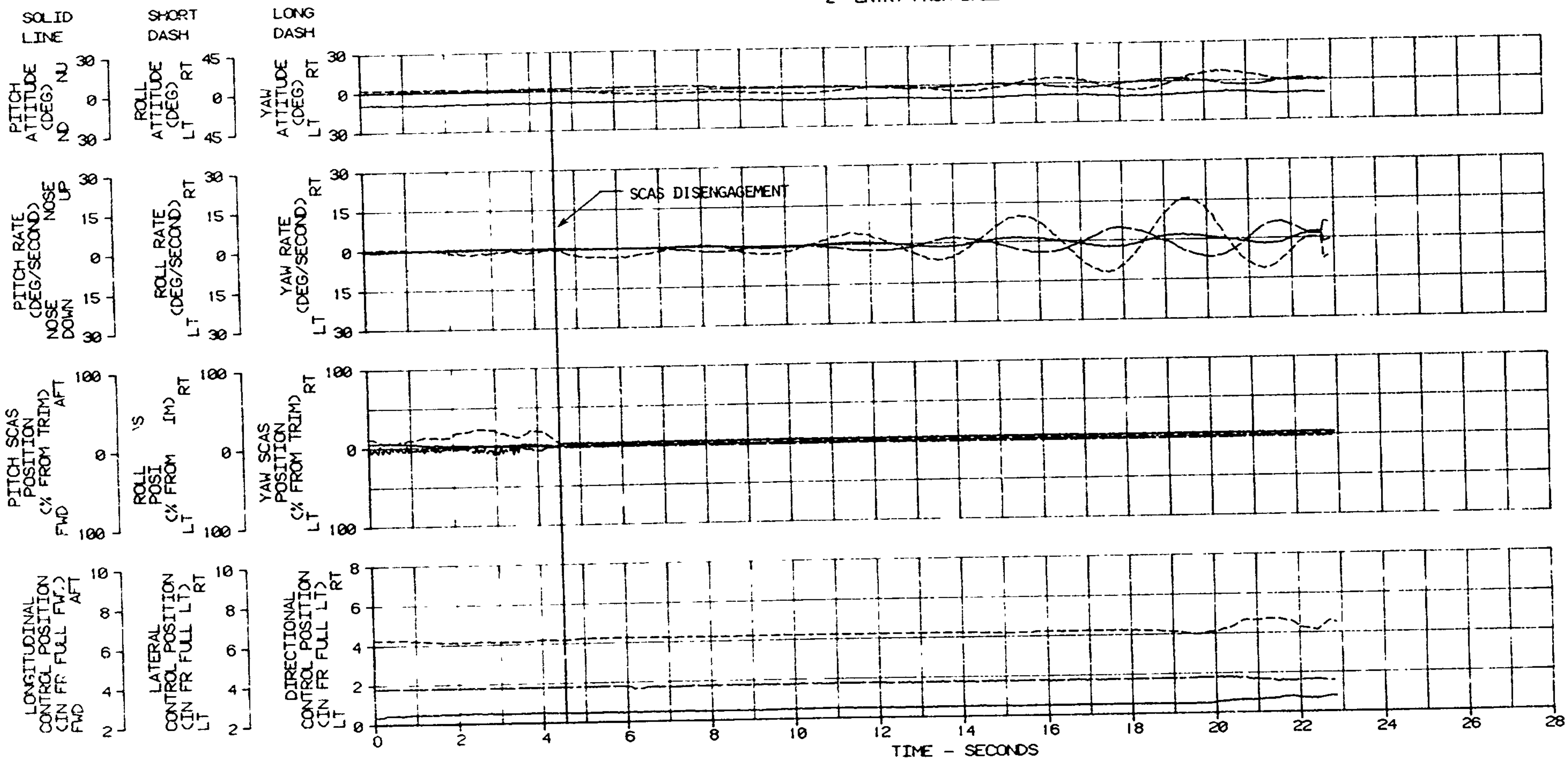


FIGURE 88

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9670 | 196 7(MID) | 2 6(LT) | 6700 | 21 5 | 321 | 90 | CLIMB |

NOTES. 1 HELLFIRE CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

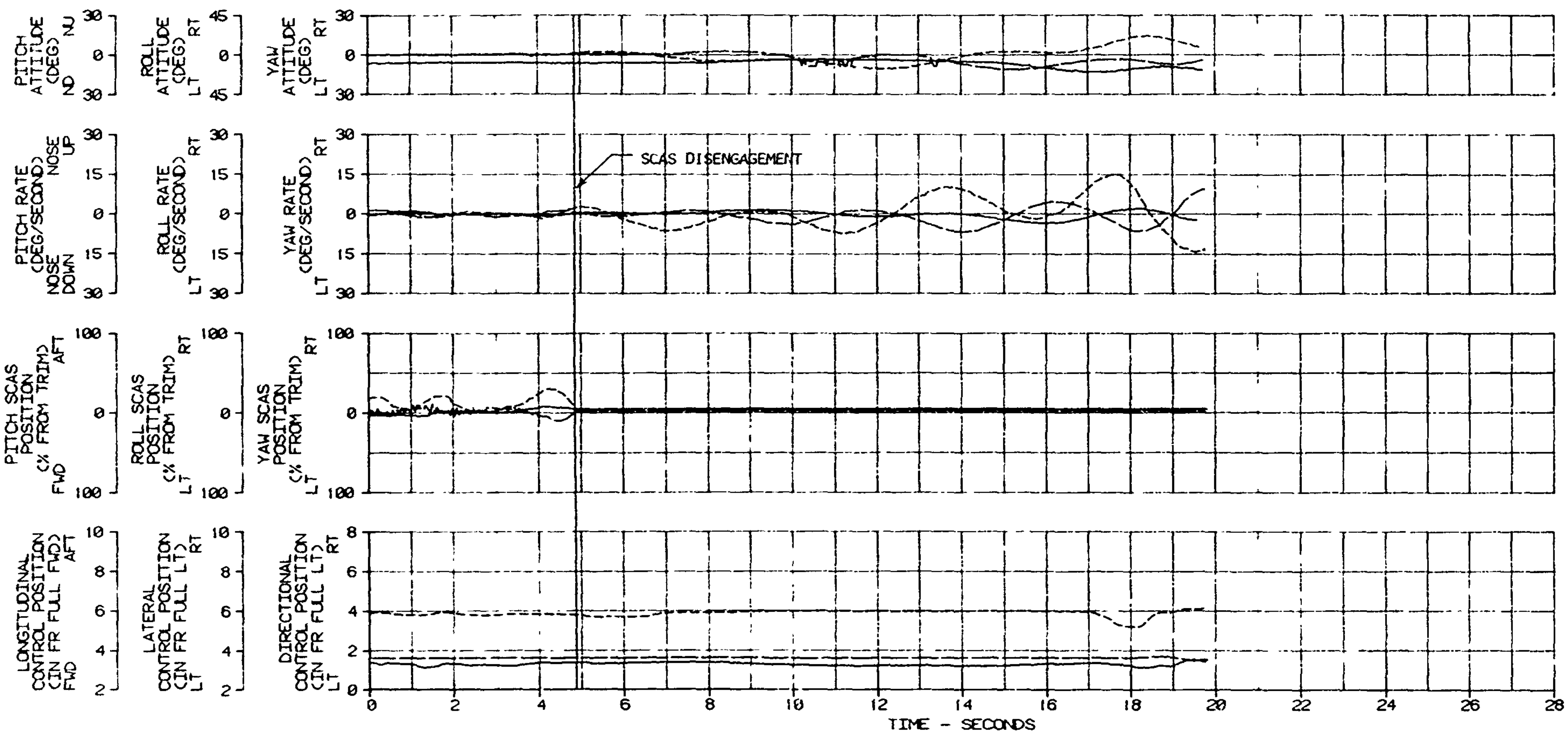


FIGURE 89

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9580 | 196.6(MID) | 2.6(LT) | 6620 | 22.0 | 322 | 106 | LEFT TURN |

NOTES 1. HELLFIRE CONFIGURATION
2. ENTRY FROM BALL CENTERED FLIGHT

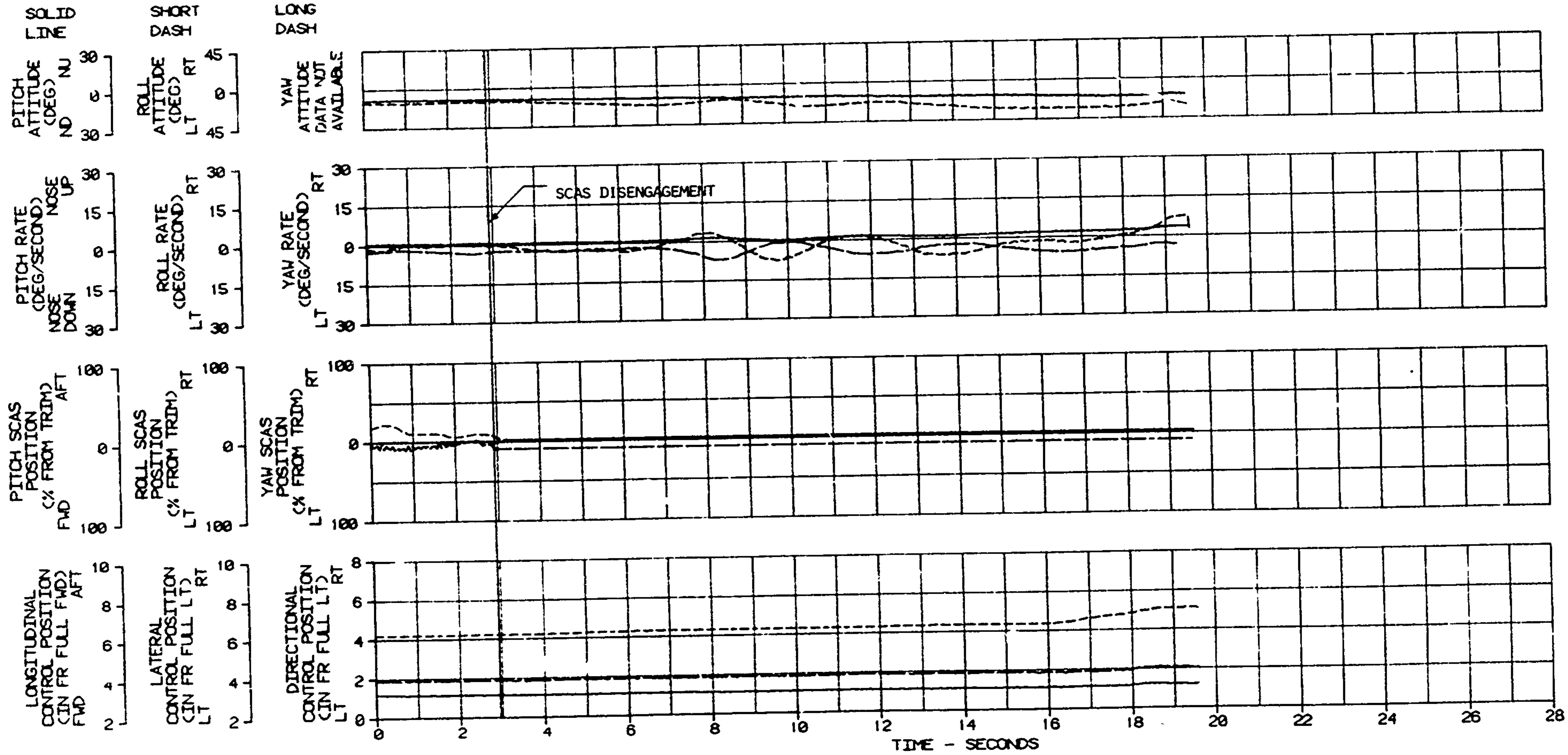


FIGURE 90

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9500 | 196 6(MID) | 2 6(LT) | 6930 | 21.0 | 322 | 106 | RIGHT TURN |

NOTES 1. HELLFIRE CONFIGURATION
2. ENTRY FROM BALL CENTERED FLIGHT

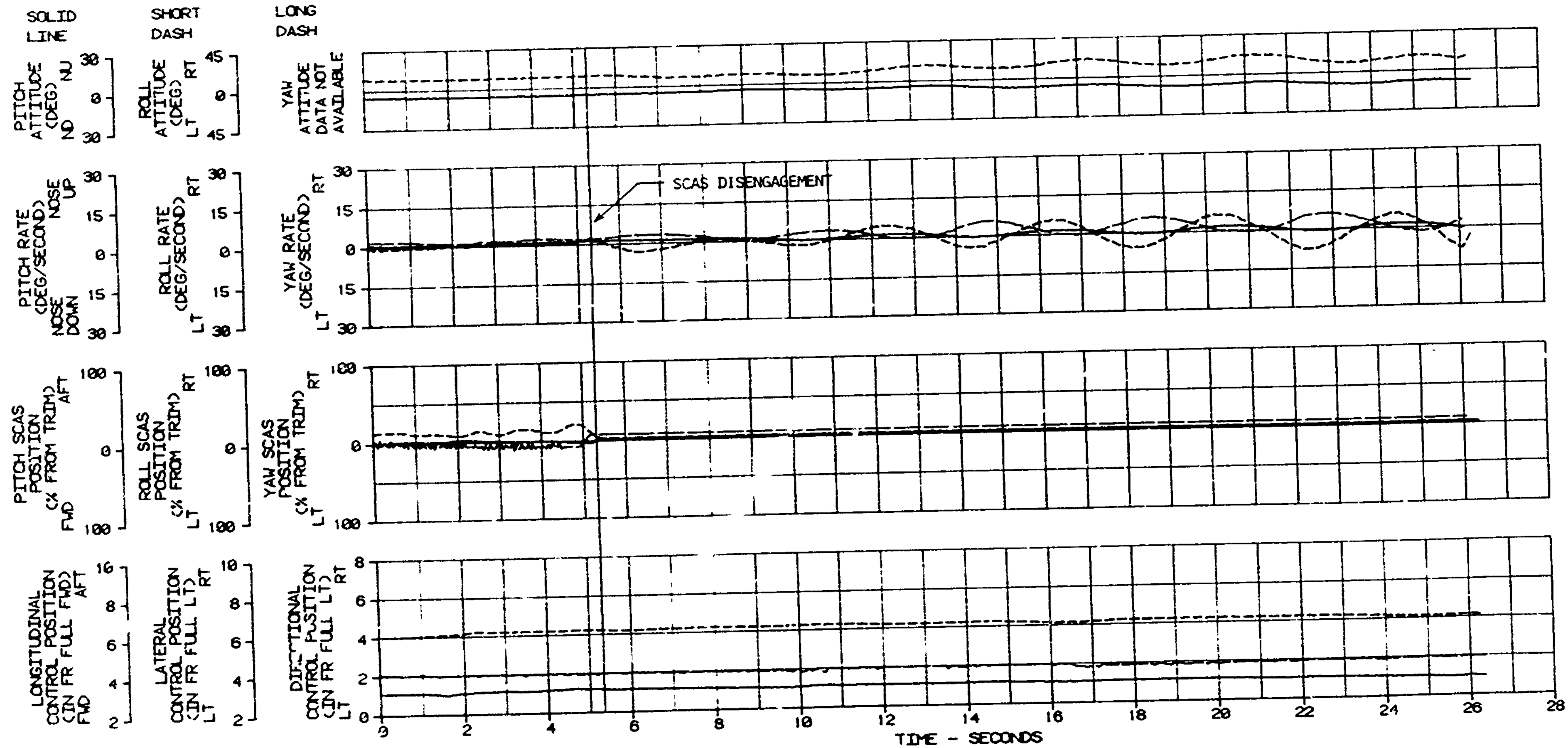


FIGURE 91

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9120 | 196 3(MID) | 2 7(LT) | 4420 | 30 0 | 320 | 0 | HOVER |

NOTES 1. HELLFIRE CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

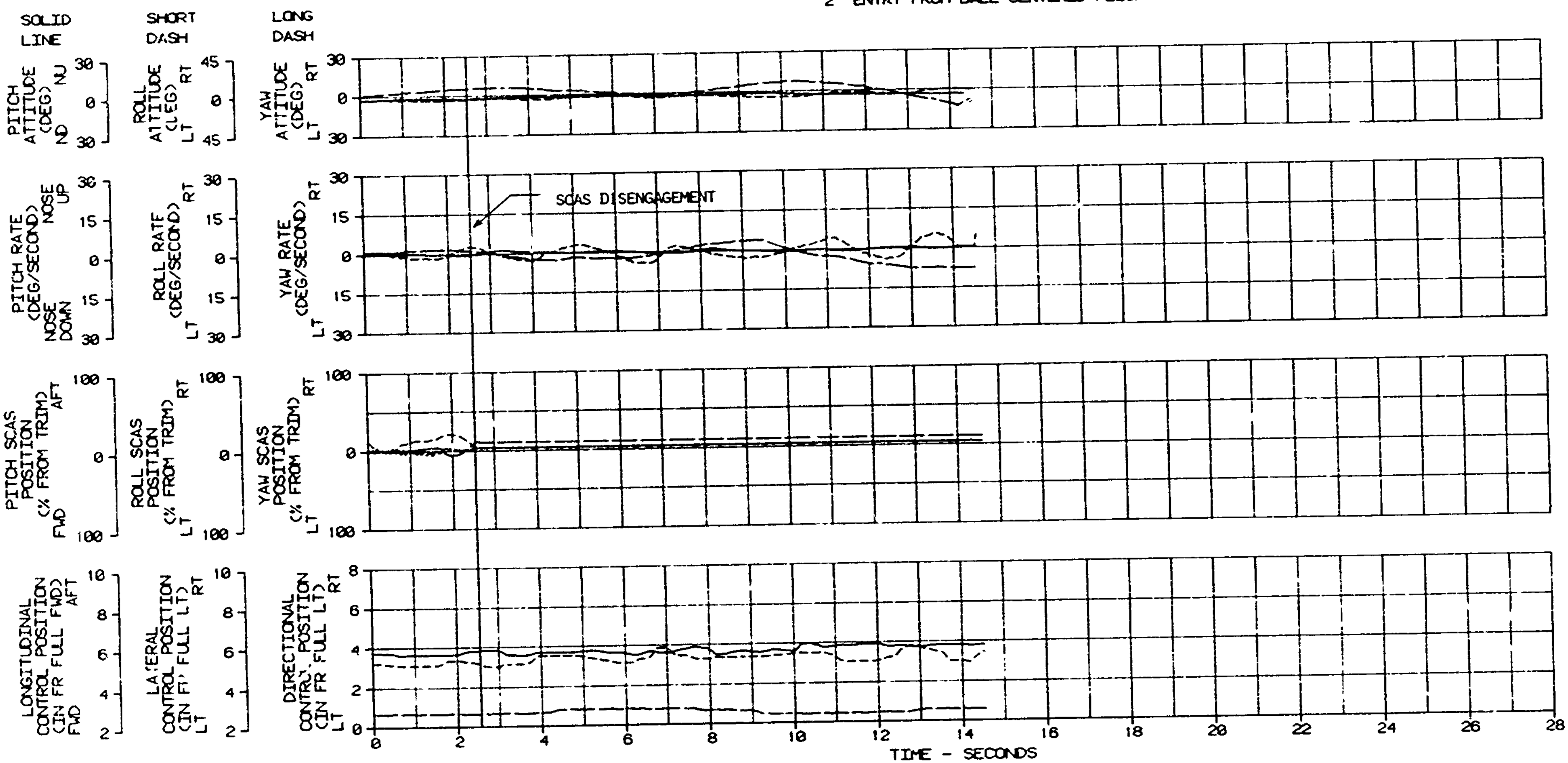


FIGURE 92

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9830 | 197.5(MID) | 1 5(LT) | 6140 | 22.5 | 323 | 137 | LEVEL |

NOTES· 1. HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

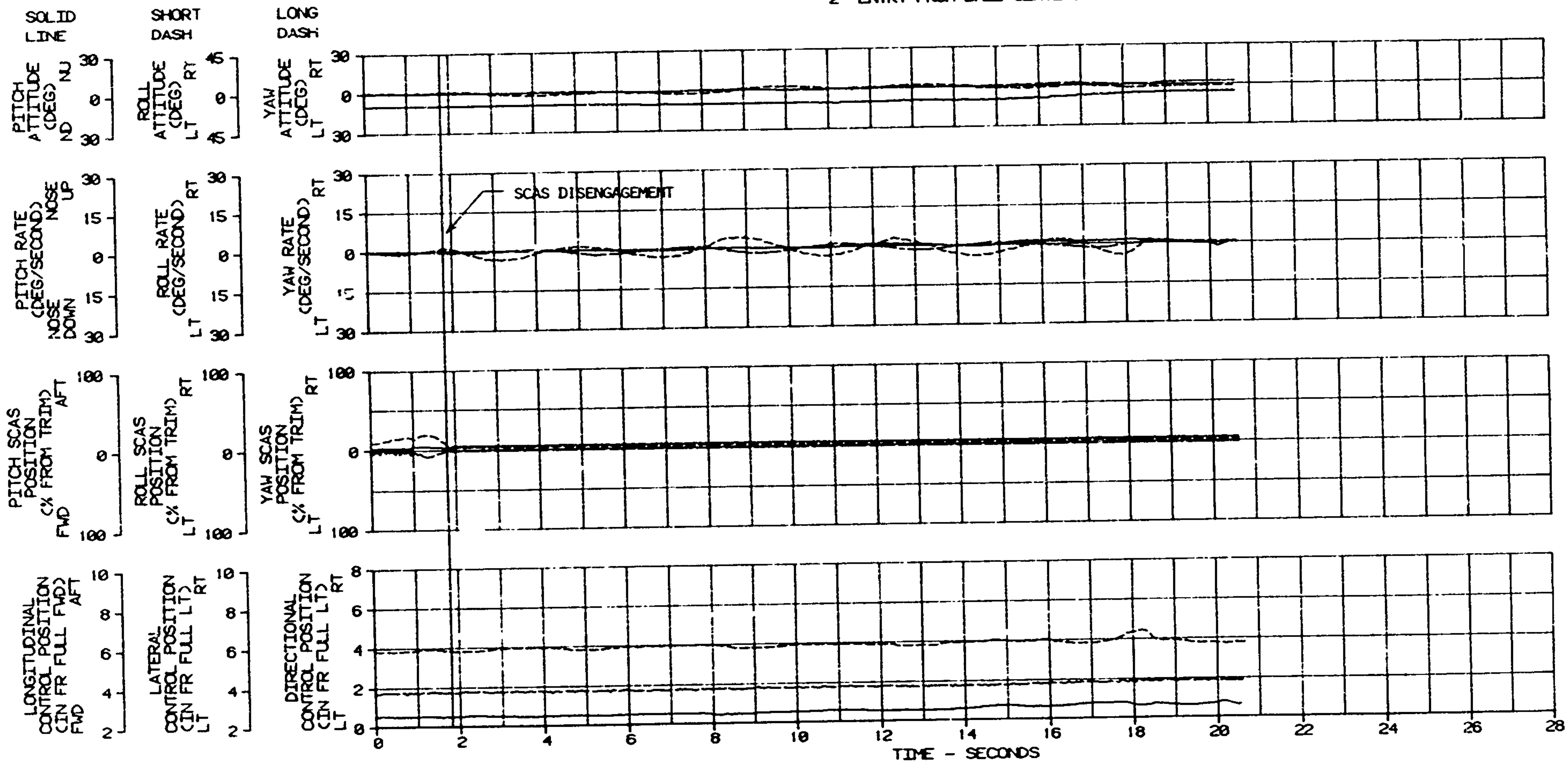


FIGURE 93

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 10230 | 196 5(MID) | 1 6(LT) | 6510 | 22 0 | 321 | 85 | AUTO |

NOTES 1. HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

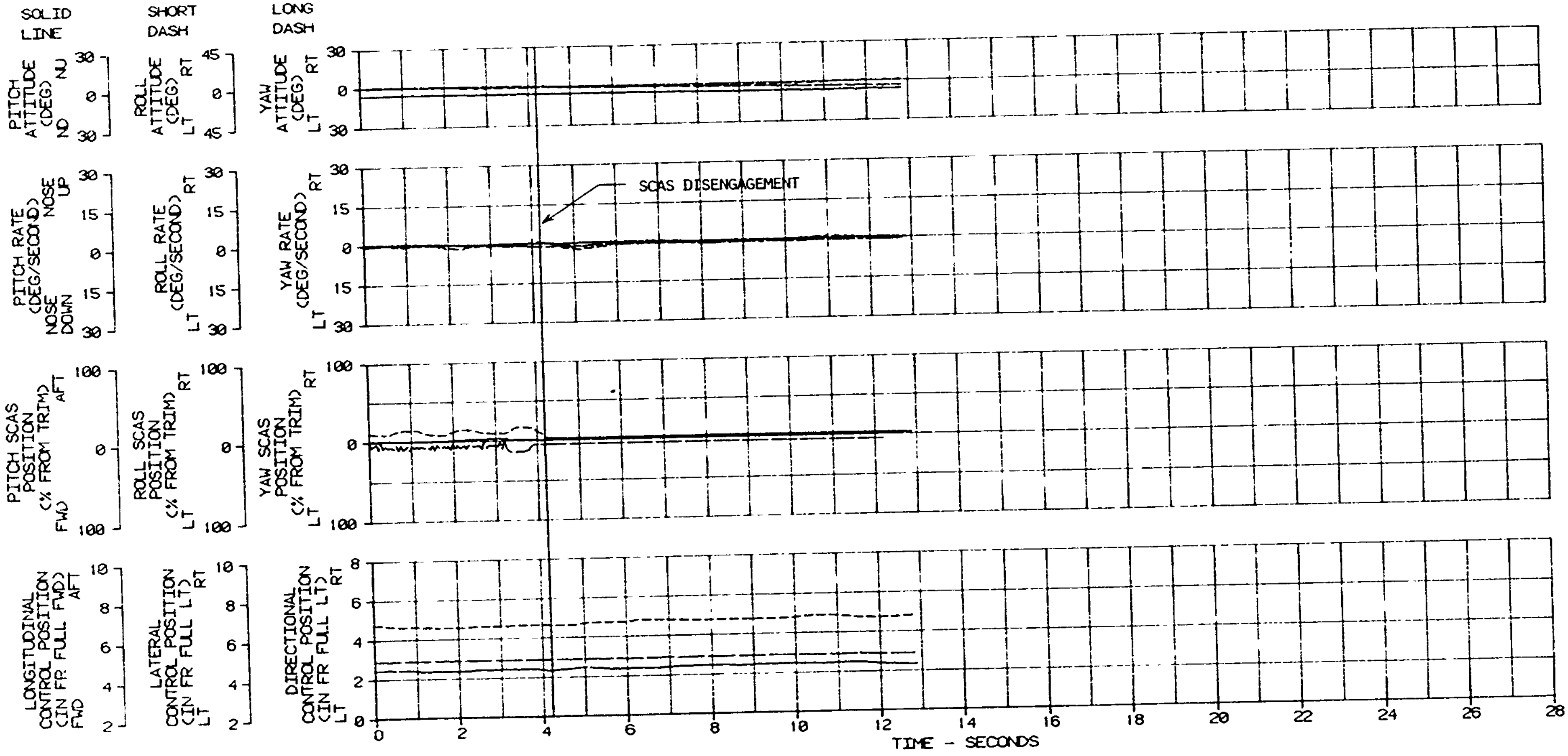


FIGURE 94

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9610 | 197 4(MID) | 1 6(LT) | 6960 | 21 5 | 323 | 108 | LEFT TURN |

NOTES 1 HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

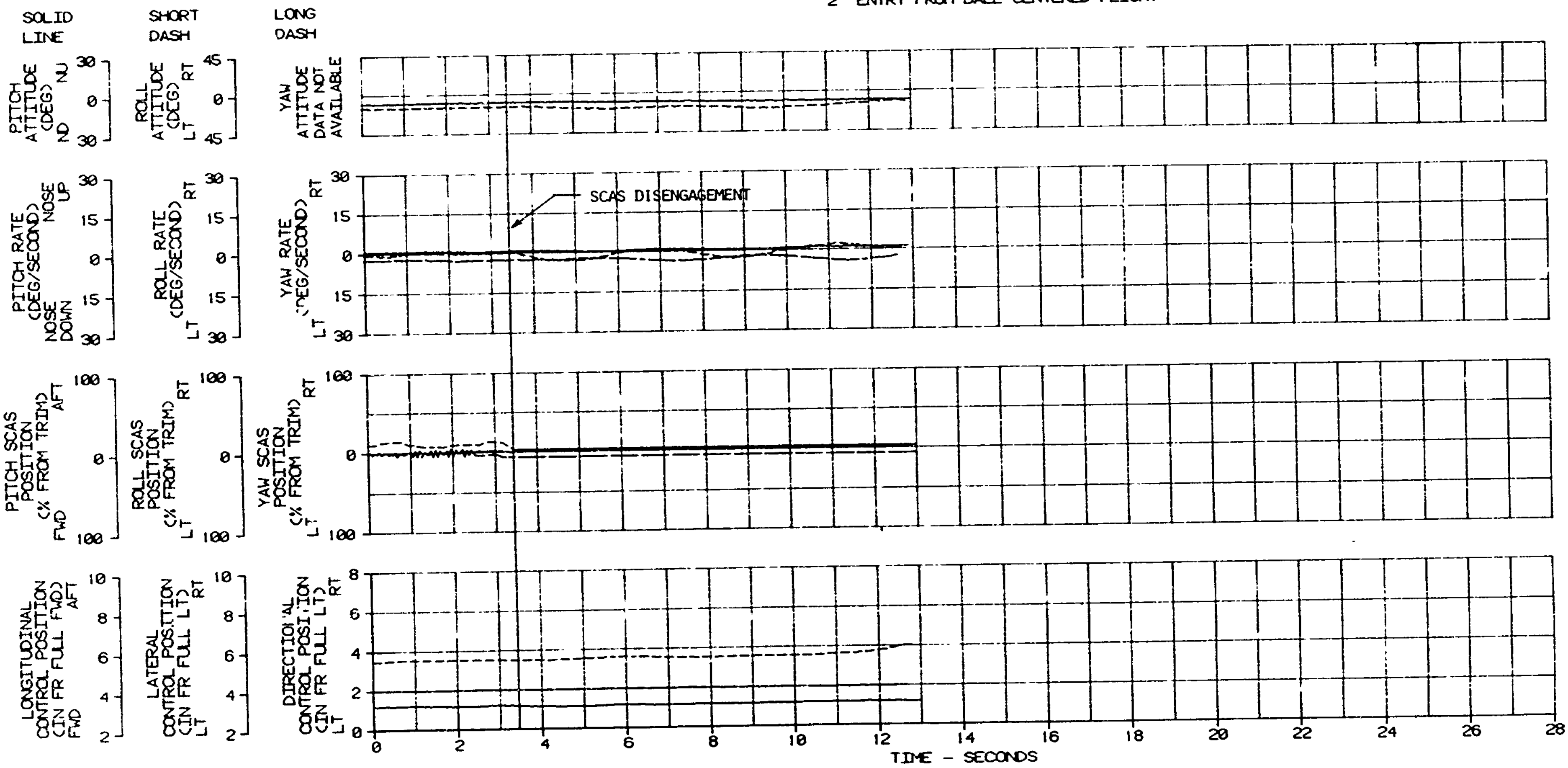


FIGURE 95

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9520 | 197 4(MID) | 1 6(LT) | 7340 | 20 5 | 323 | 106 | RIGHT TURN |

NOTES 1 HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

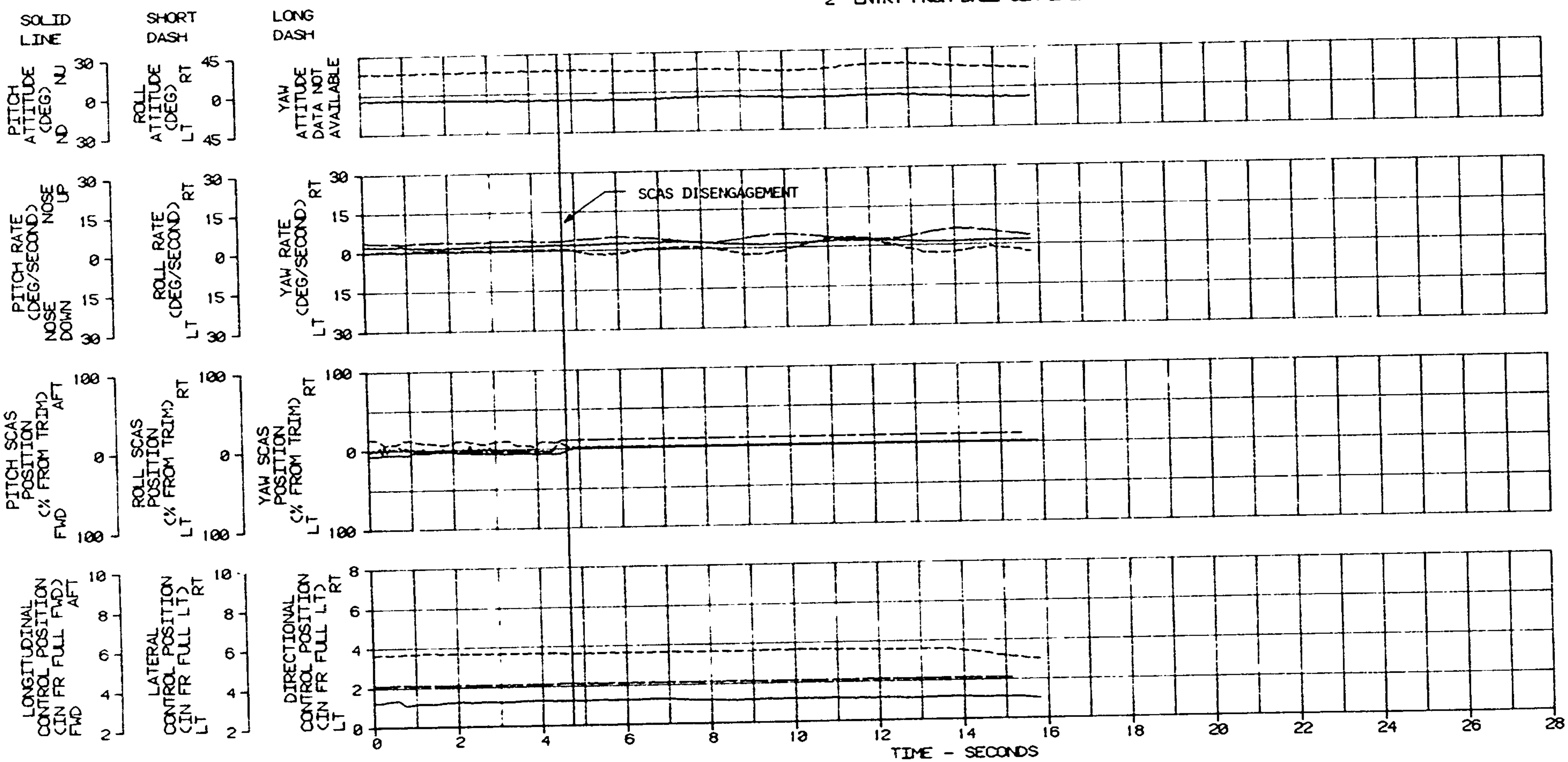


FIGURE 96

SCAS DISENGAGEMENT
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9450 | 196 8(MID) | 1 6(LT) | 8460 | 22 5 | 321 | 105 | LEVEL |

NOTES 1 STINGER/HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT

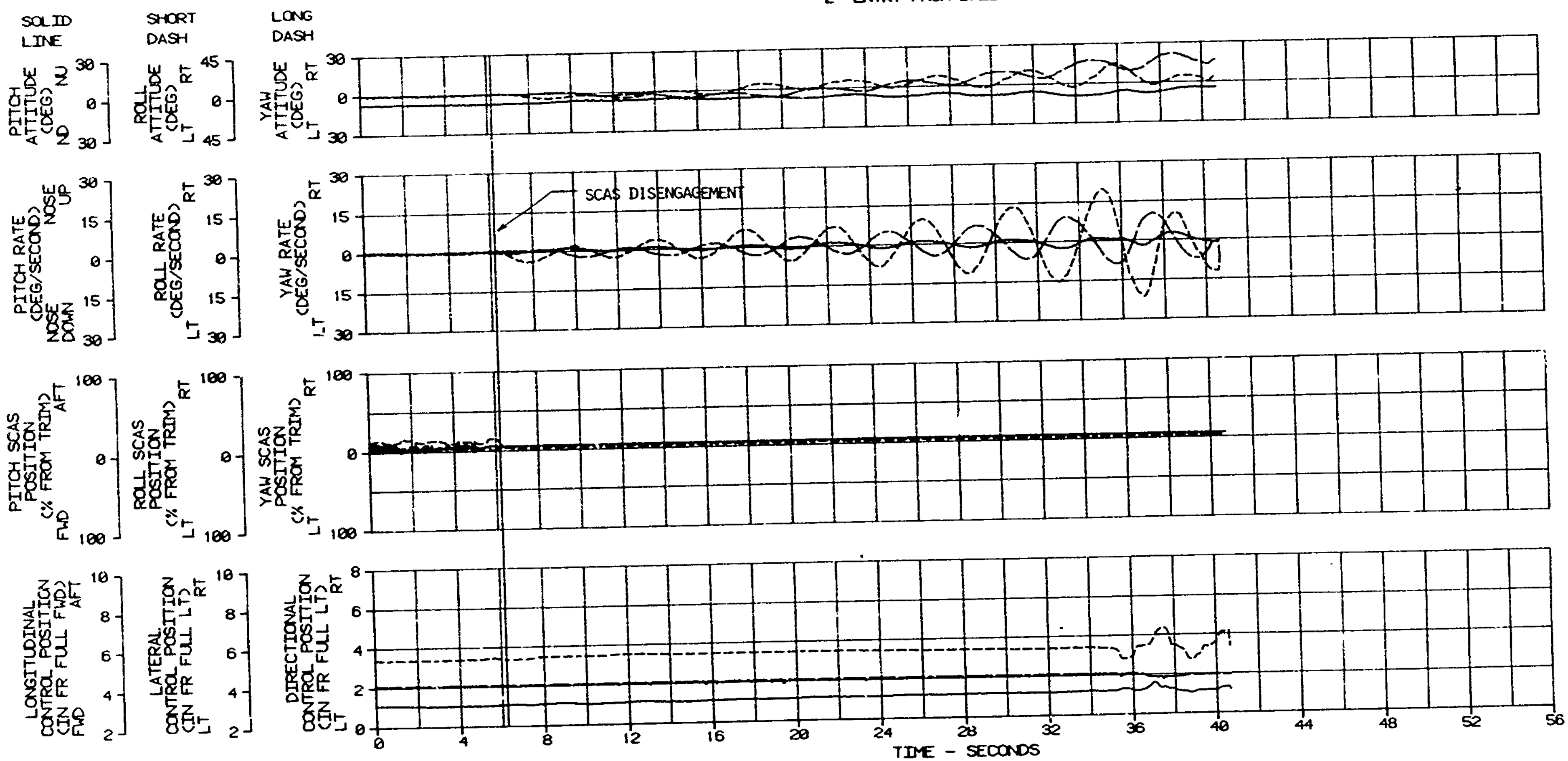


FIGURE 97

SCAS HARDOVER - ROLL CHANNEL
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9360 | 196 5(MID) | 2 6(LT) | 6820 | 22 0 | 322 | 104 | LEVEL |

NOTES
1 HELLFIRE CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT
3 PITCH AND YAW SCAS ON

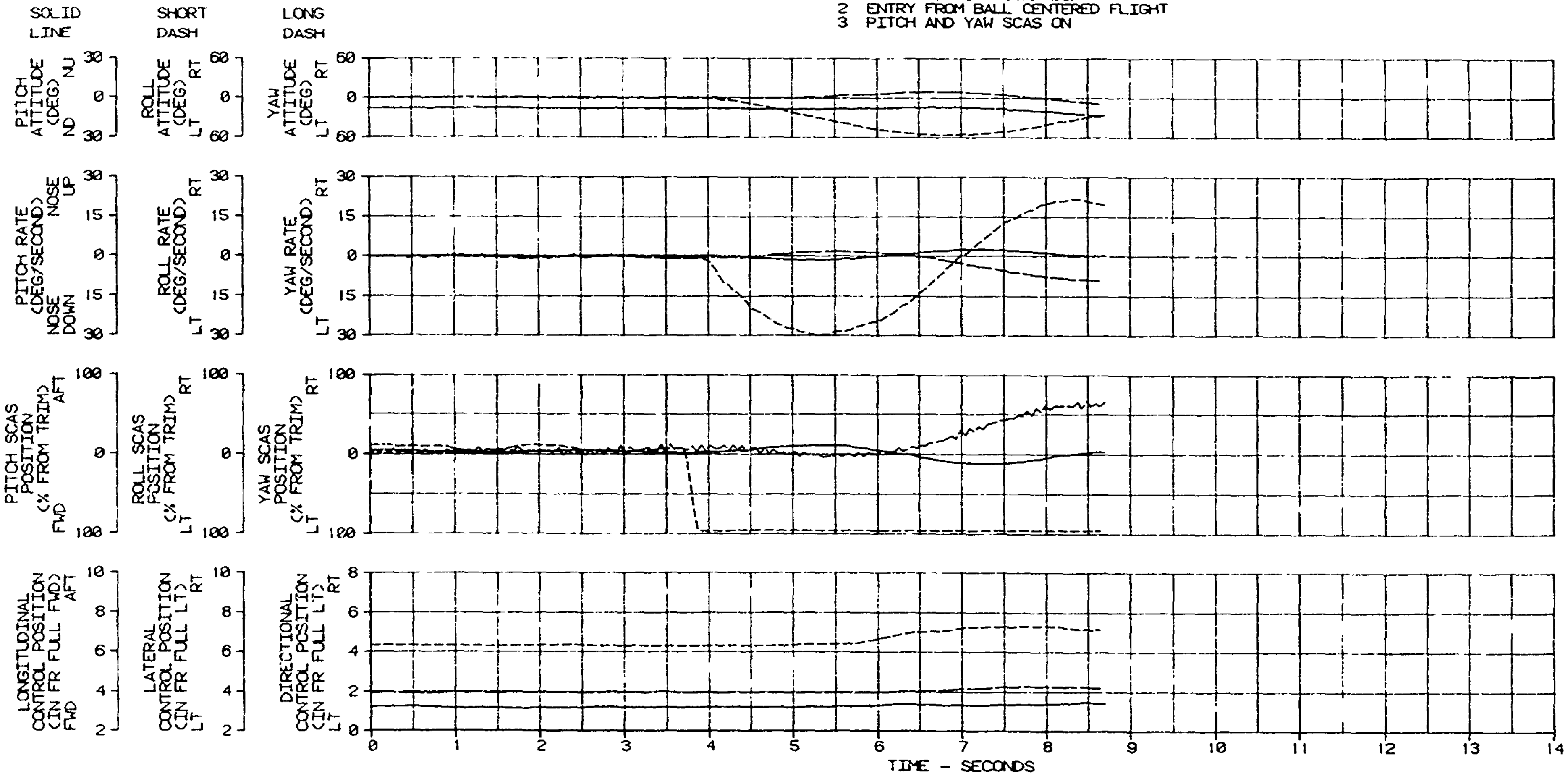


FIGURE 98

SCAS HARDOVER - ROLL CHANNEL
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9240 | 196 4(MID) | 2 7(LT) | 6860 | 21 5 | 322 | 106 | LEVEL |

NOTES 1 HELLFIRE CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT
3 PITCH AND YAW SCAS ON

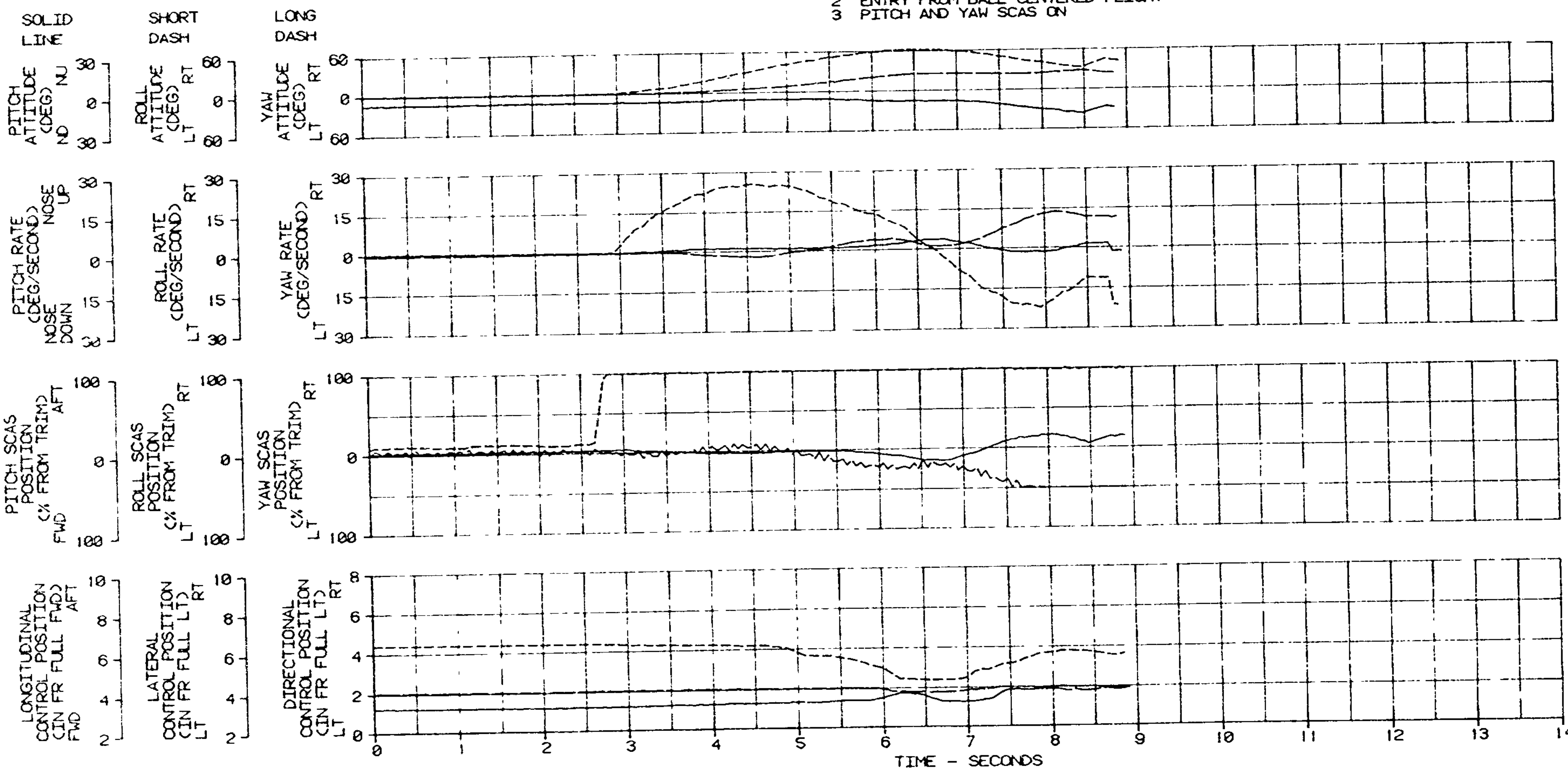


FIGURE 99

SCAS HARDOVER - ROLL CHANNEL
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9320 | 197 2(MID) | 1 6(LT) | 6790 | 21 5 | 323 | 106 | LEVEL |

NOTES 1 HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT
3 PITCH AND YAW SCAS ON

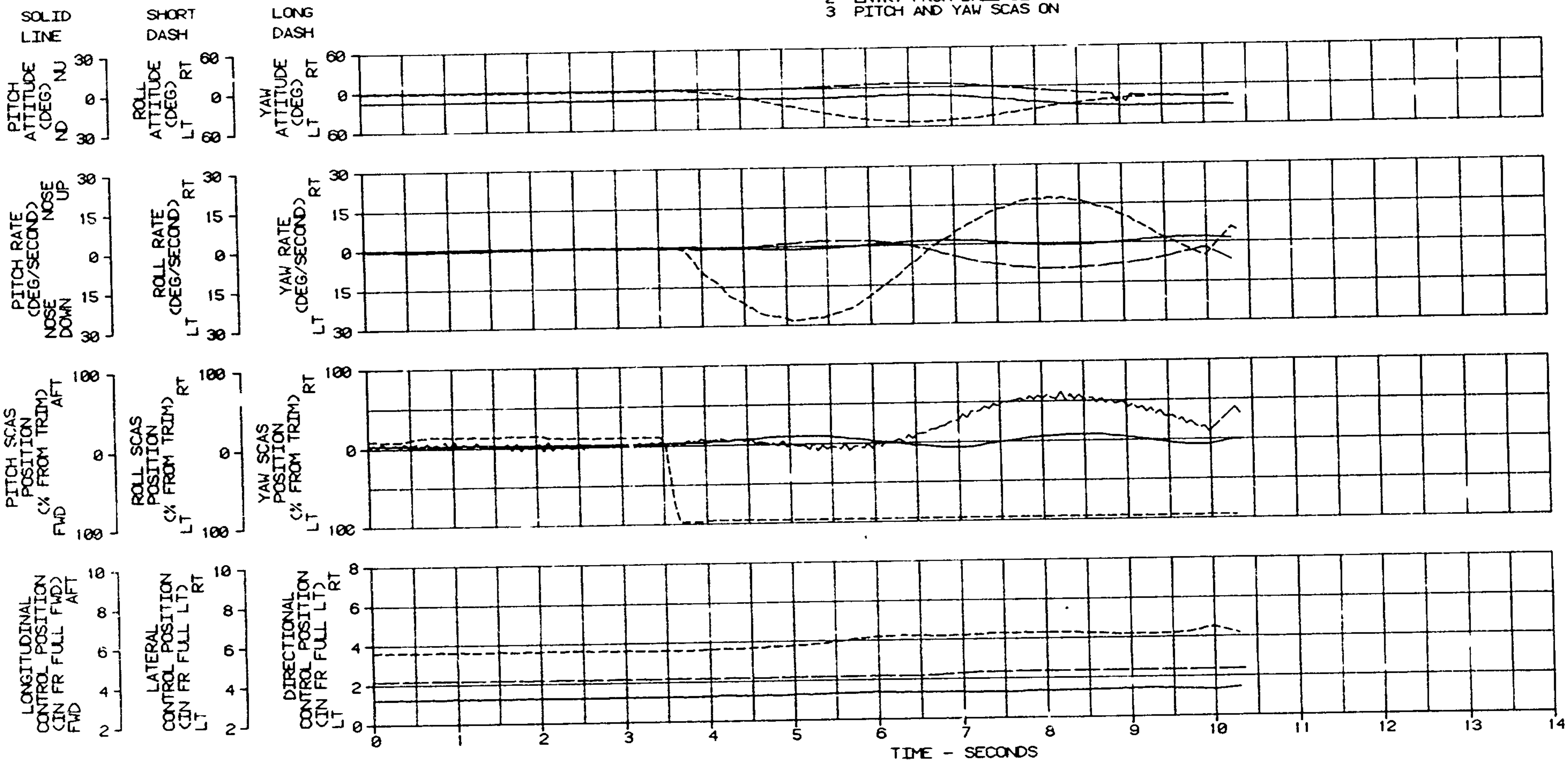


FIGURE 100

SCAS HARDOVER - ROLL CHANNEL
AH-1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALTITUDE (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | TRIM CALIBRATED AIRSPEED (KT) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|---|
| 9250 | 197 2(MID) | 1 6(LT) | 6950 | 21 5 | 322 | 107 | LEVEL |

NOTES
1 HELLFIRE/TOW CONFIGURATION
2 ENTRY FROM BALL CENTERED FLIGHT
3 PITCH AND YAW SCAS ON

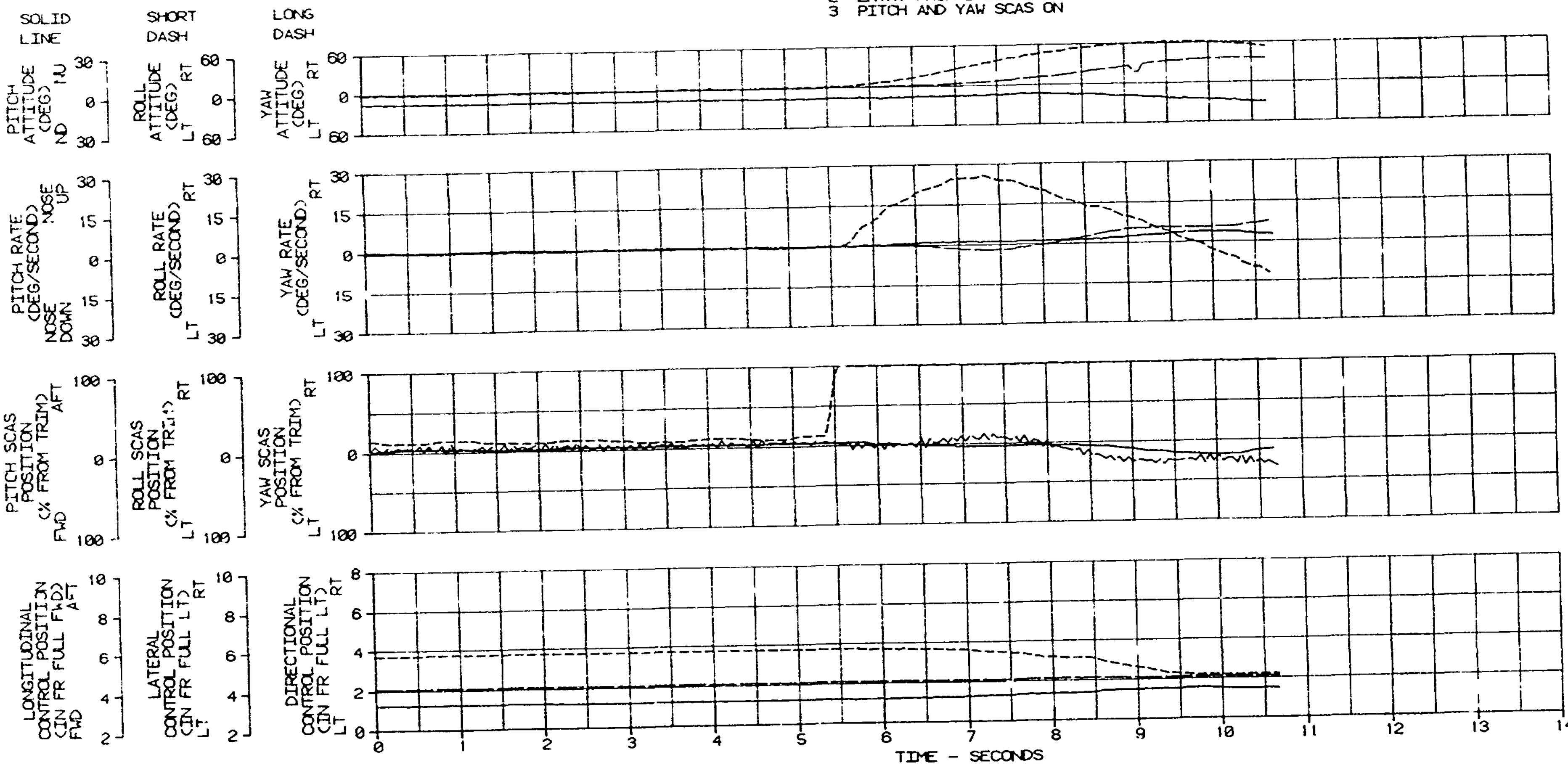
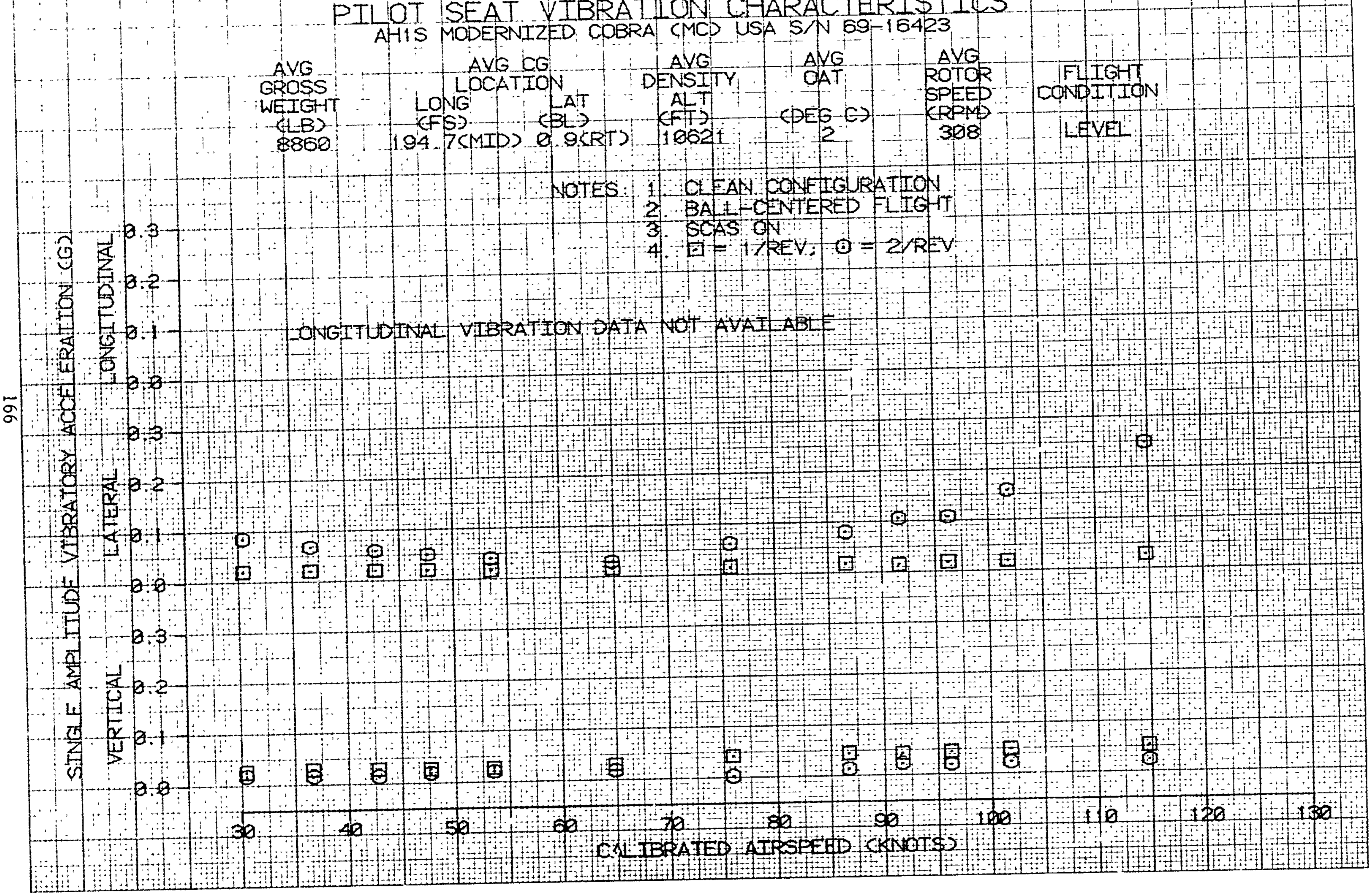


FIGURE 101


PILOT SEAT VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 8860
AVG CG LOCATION LONG (FS) 194.7(MID) LAT (BL) 0.9(RT)
AVG DENSITY ALT (FT) 10621
AVG OAT (DEG C) 2
AVG ROTOR SPEED (RPM) 308
FLIGHT CONDITION LEVEL
NOTES: 1. CLEAN CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. ⊡ = 1/REV, ⊙ = 2/REV
LONGITUDINAL VIBRATION DATA NOT AVAILABLE
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.0
0.1
0.2
0.3
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

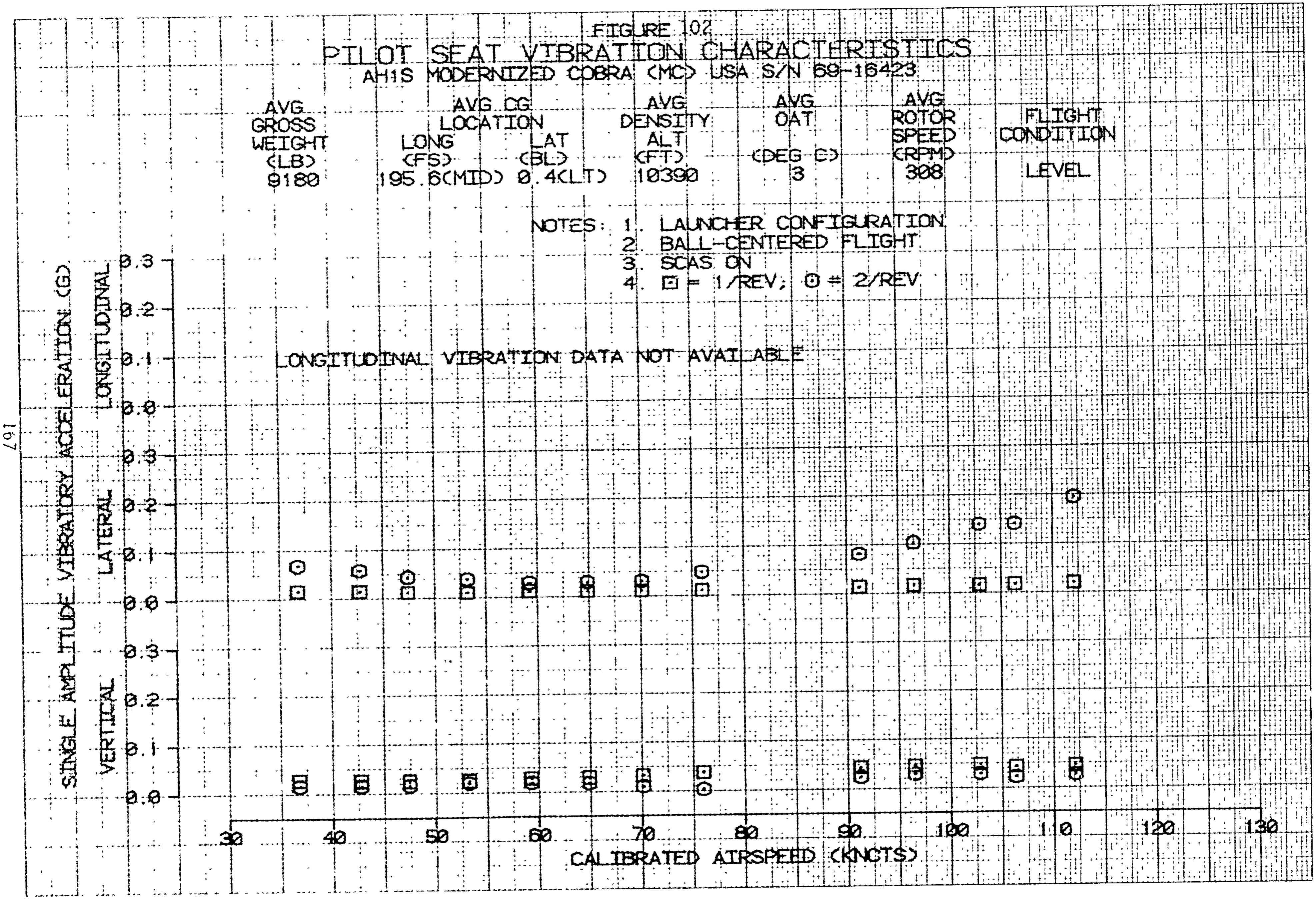


FIGURE 102
PILOT SEAT VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9180
AVG CG LOCATION LONG (FS) 195.6(MID) LAT (BL) 0.4(LT)
AVG DENSITY ALT (FT) 10390
AVG OAT (DEG C) 3
AVG ROTOR SPEED (RPM) 308
FLIGHT CONDITION LEVEL
NOTES: 1. LAUNCHER CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. ⊡ = 1/REV; ⊙ = 2/REV
LONGITUDINAL VIBRATION DATA NOT AVAILABLE
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.3
0.2
0.1
0.0
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

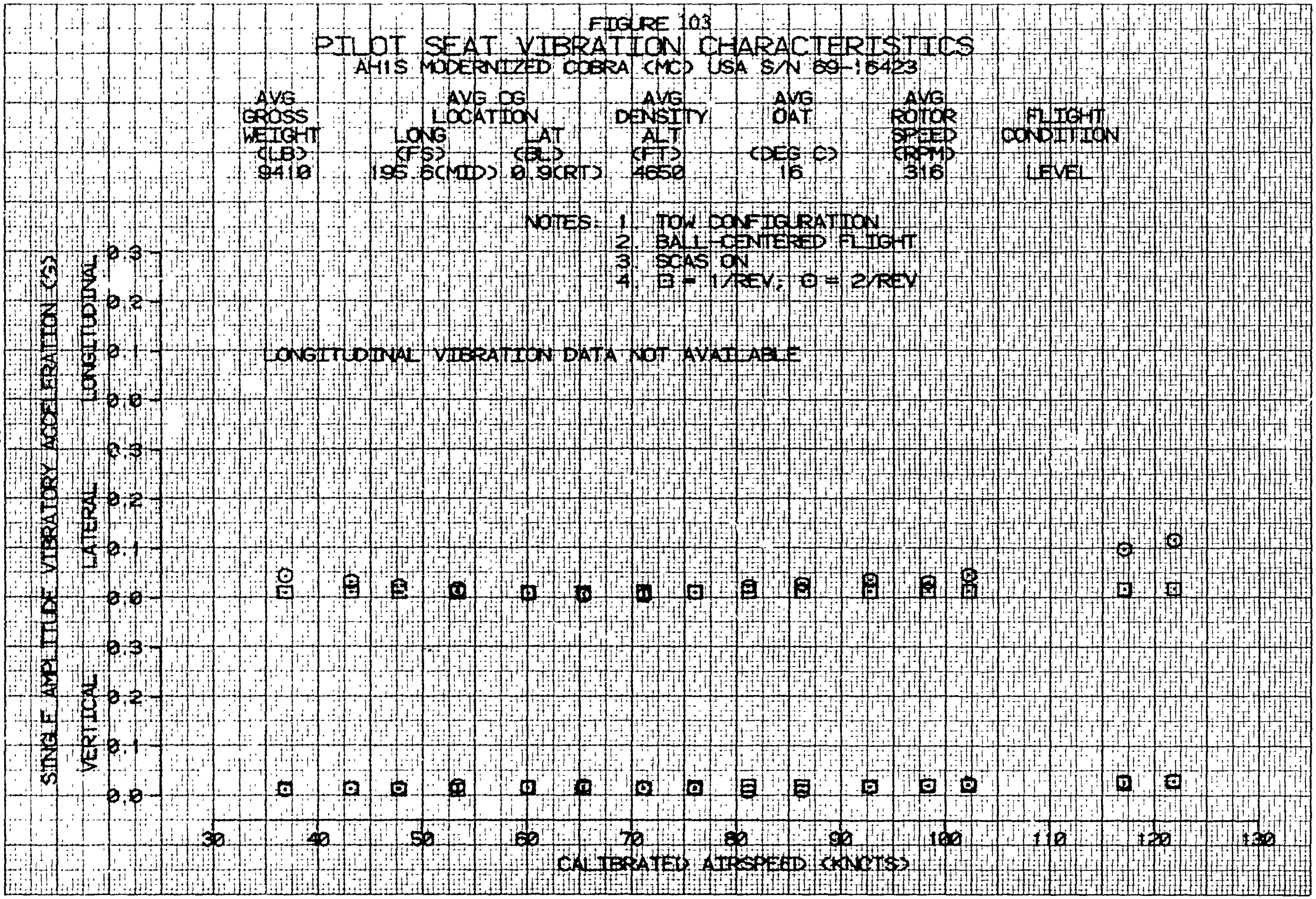



FIGURE 103
PILOT SEAT VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

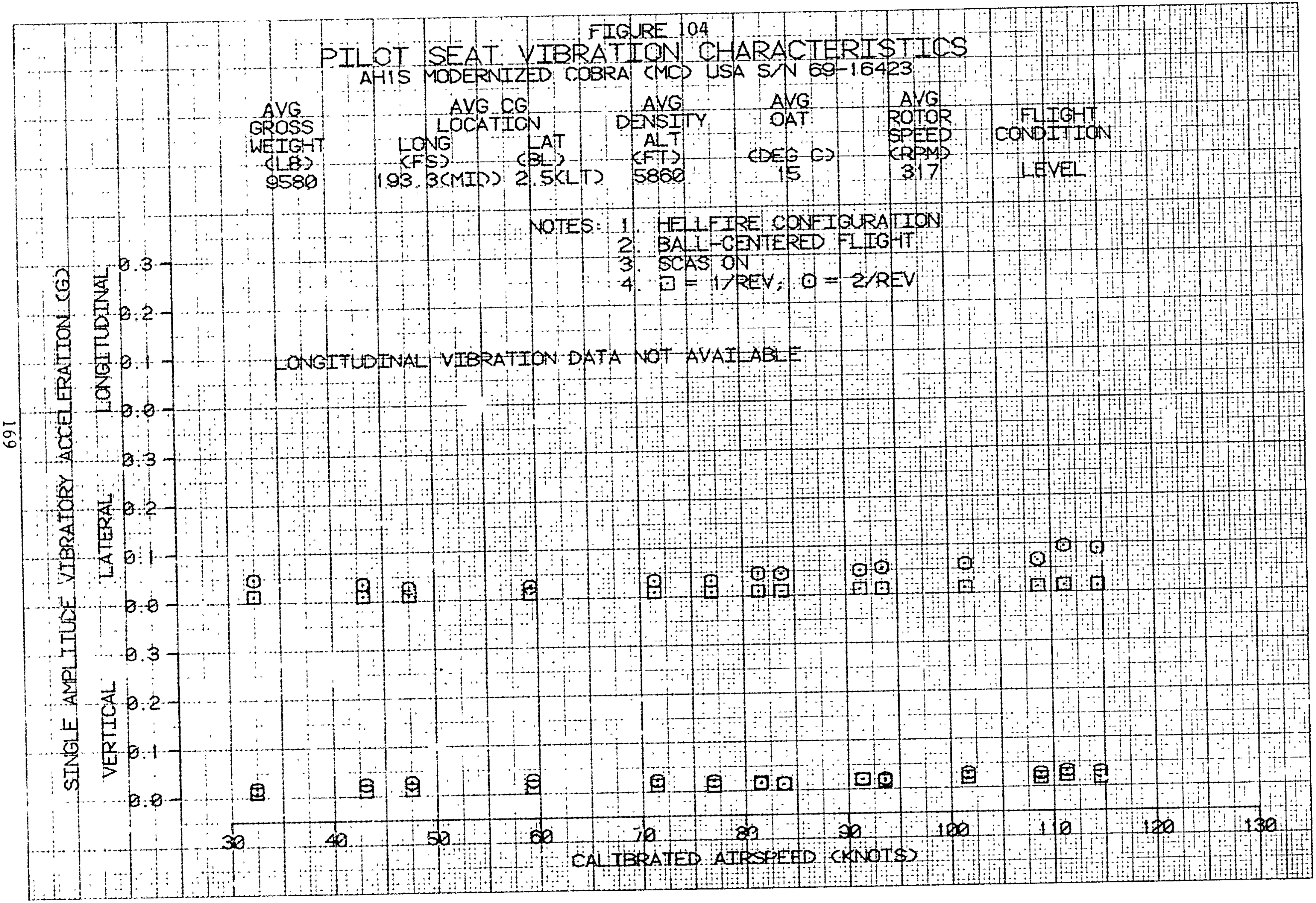
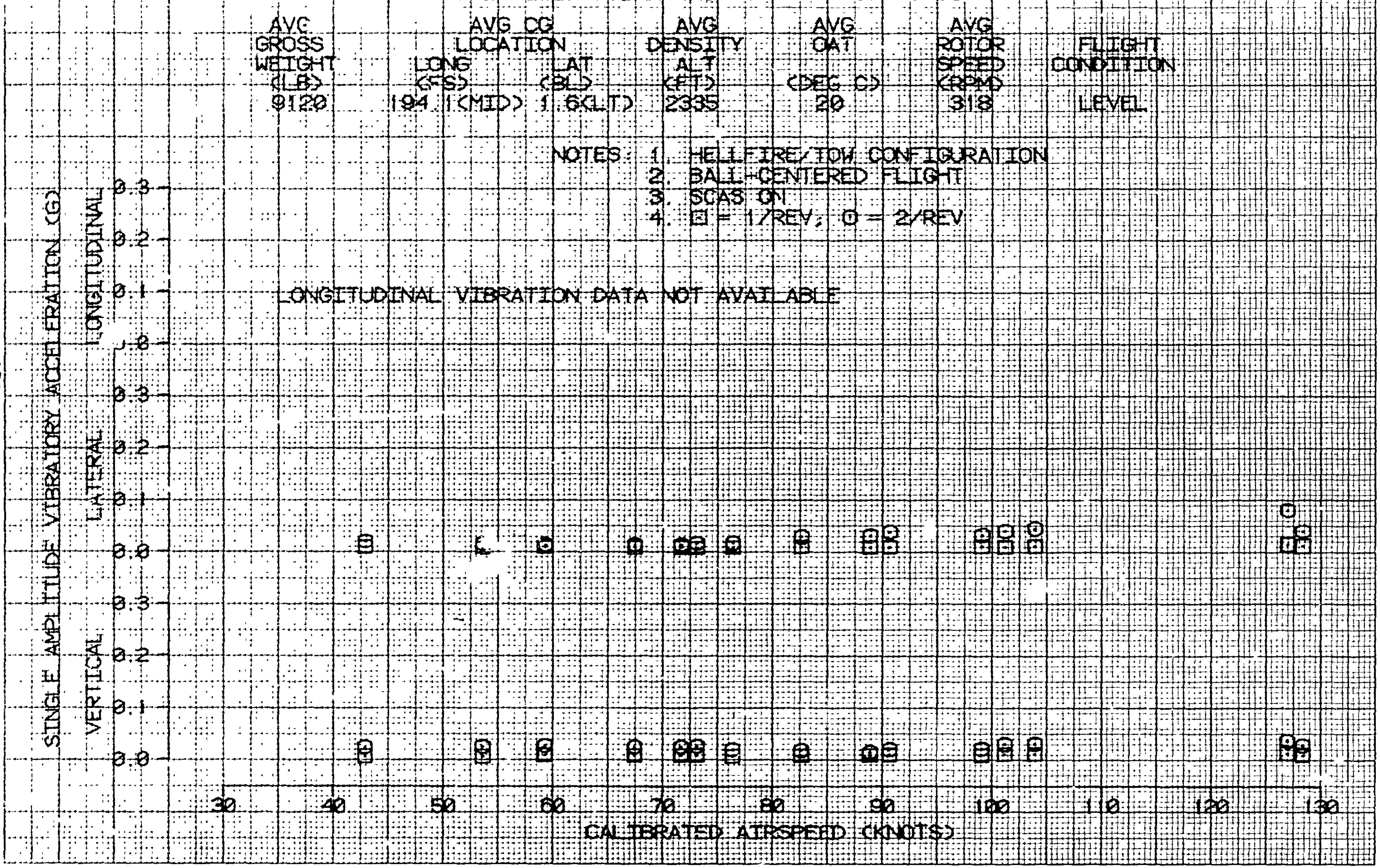


FIGURE 104
PILOT SEAT VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9580
AVG CG LOCATION LONG (FS) 193.3(MID) LAT (BL) 2.5(LT)
AVG DENSITY ALT (FT) 5860
AVG OAT (DEG C) 15
AVG ROTOR SPEED (RPM) 317
FLIGHT CONDITION LEVEL
NOTES: 1. HELLFIRE CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; ○ = 2/REV
LONGITUDINAL VIBRATION DATA NOT AVAILABLE
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.0
0.1
0.2
0.3
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

FIGURE 105

PILOT SEAT VIBRATION CHARACTERISTICS

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423



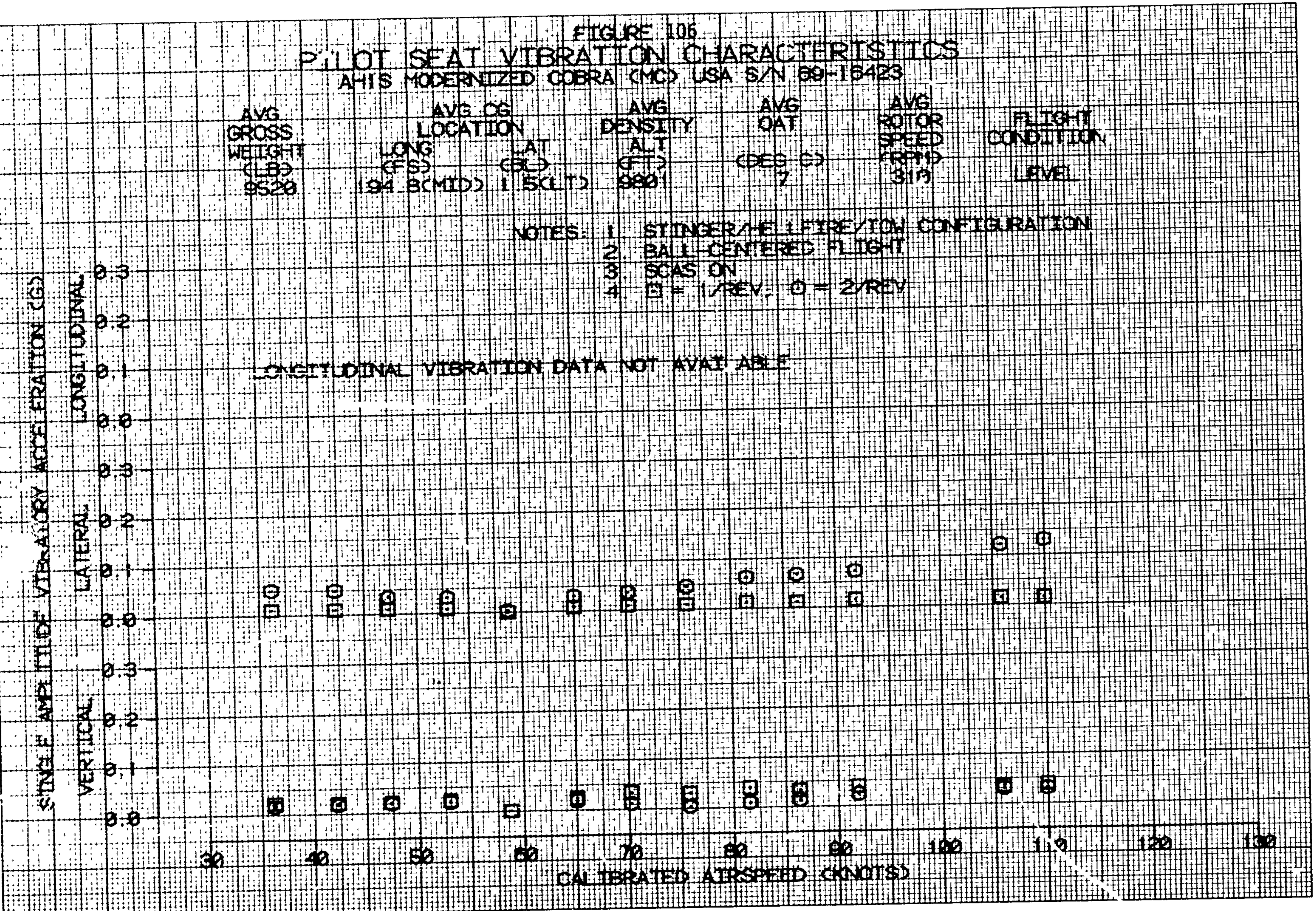


FIGURE 106
PILOT SEAT VIBRATION CHARACTERISTICS
AHIS MODERNIZED COBRA (MC) USA S/N 80-16423
AVG GROSS WEIGHT (LB) 9520
AVG CG LOCATION LONG (FS) 194.8(MID) LAT (BL) 1.5(LT)
AVG DENSITY ALT (FT) 980
AVG OAT (DEG C) 7
AVG ROTOR SPEED (RPM) 319
FLIGHT CONDITION LEVEL
NOTES: 1. STINGER/HELLFIRE/TOW CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV, ○ = 2/REV
LONGITUDINAL VIBRATION DATA NOT AVAILABLE
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.0
0.1
0.2
0.3
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

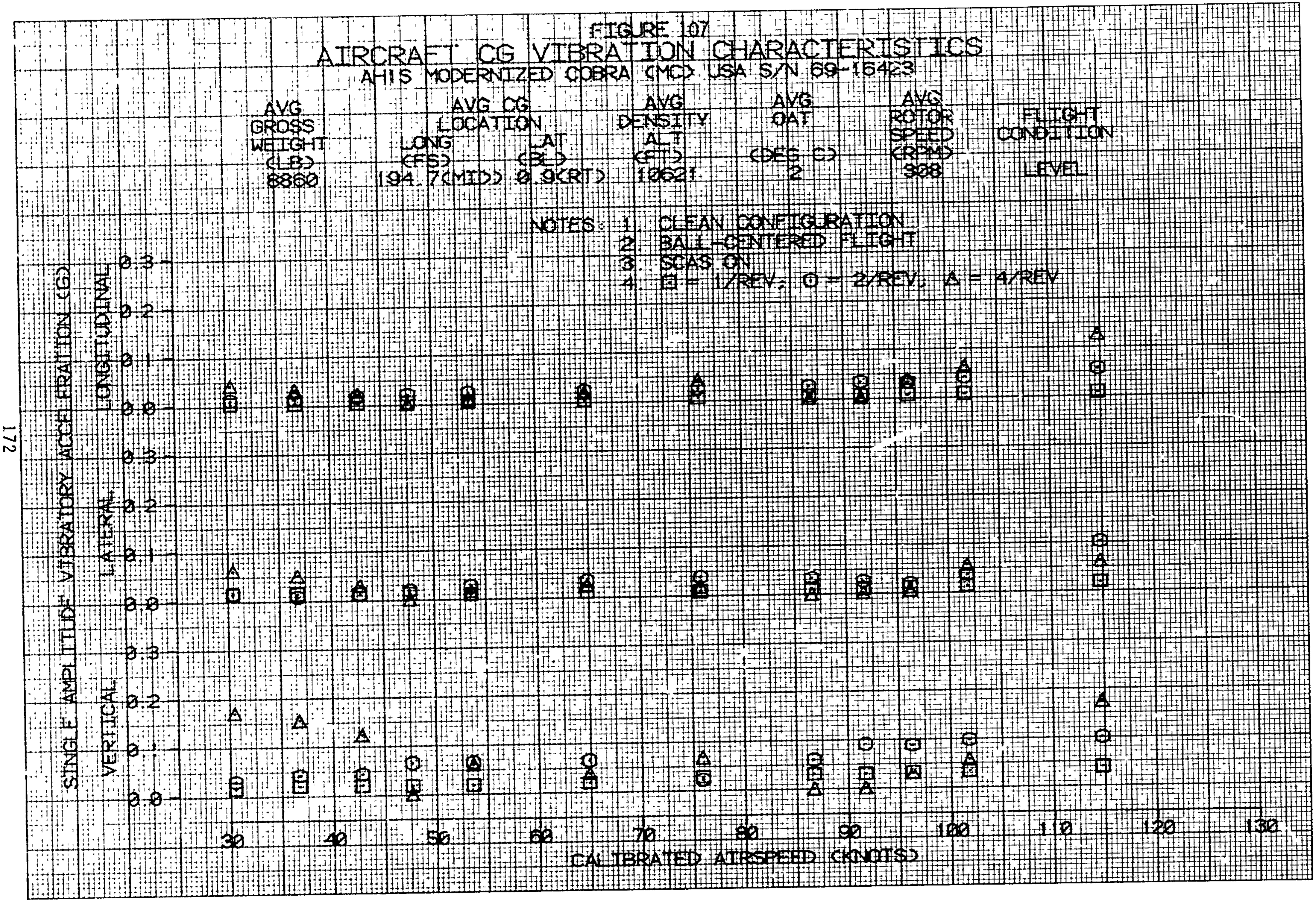


FIGURE 107
AIRCRAFT CG VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 8860
AVG CG LOCATION LONG (FS) 194.7(MID) LAT (BL) 0.9(RT)
AVG DENSITY ALT (FT) 10621
AVG OAT (DEG C) 2
AVG ROTOR SPEED (RPM) 308
FLIGHT CONDITION LEVEL
NOTES: 1. CLEAN CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; O = 2/REV; Δ = 4/REV
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.3
0.2
0.1
0.0
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

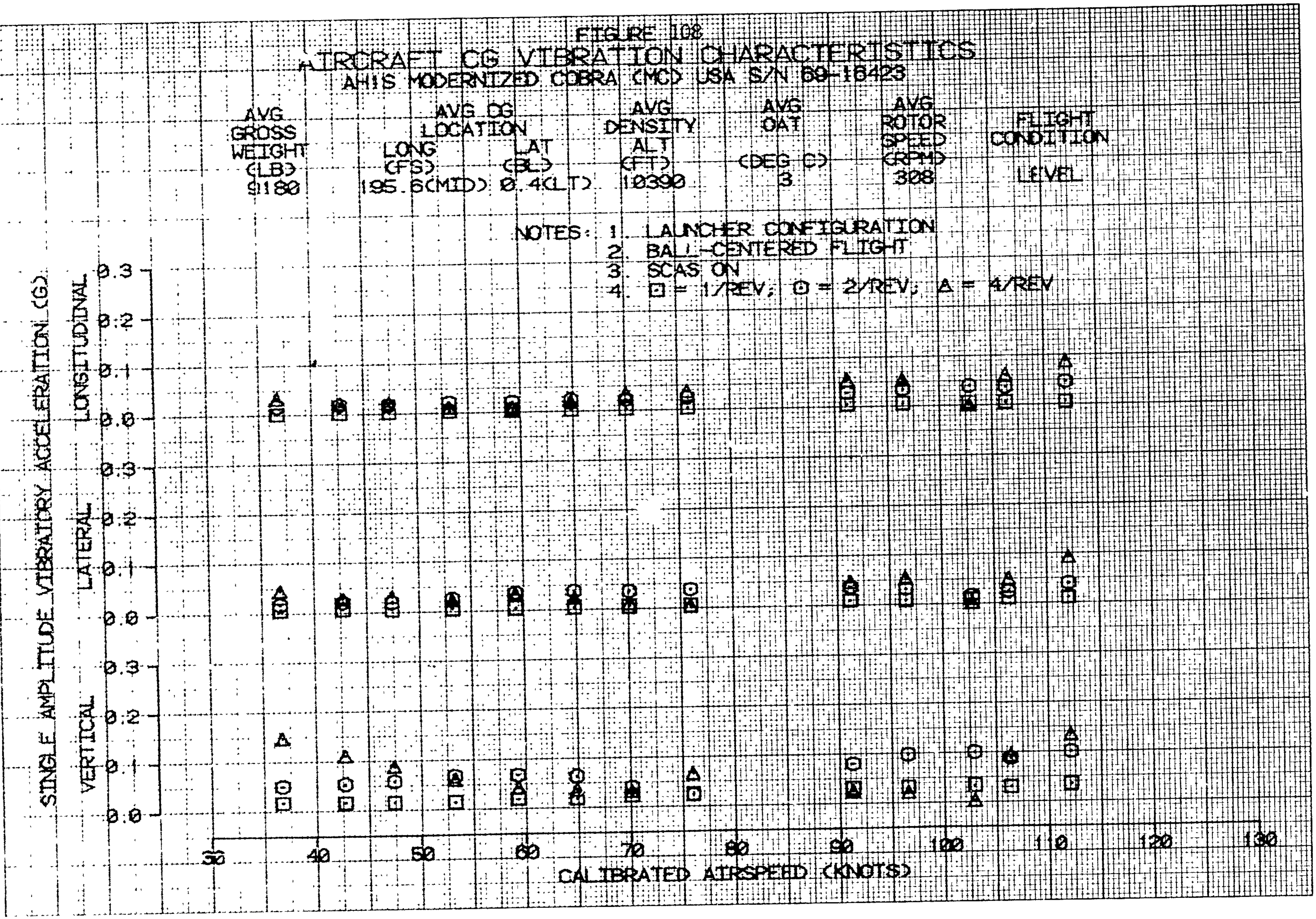


FIGURE 108
AIRCRAFT CG VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9180
AVG CG LOCATION LONG (FS) 195.6(MID) LAT (BL) 0.4(LT)
AVG DENSITY ALT (FT) 10390
AVG OAT (DEG C) 3
AVG ROTOR SPEED (RPM) 308
FLIGHT CONDITION LEVEL
NOTES: 1. LAUNCHER CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; ⊙ = 2/REV; △ = 4/REV
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.0
0.1
0.2
0.3
CALIBRATED AIRSPEED (KNOTS)
30
40
50
60
70
80
90
100
110
120
130

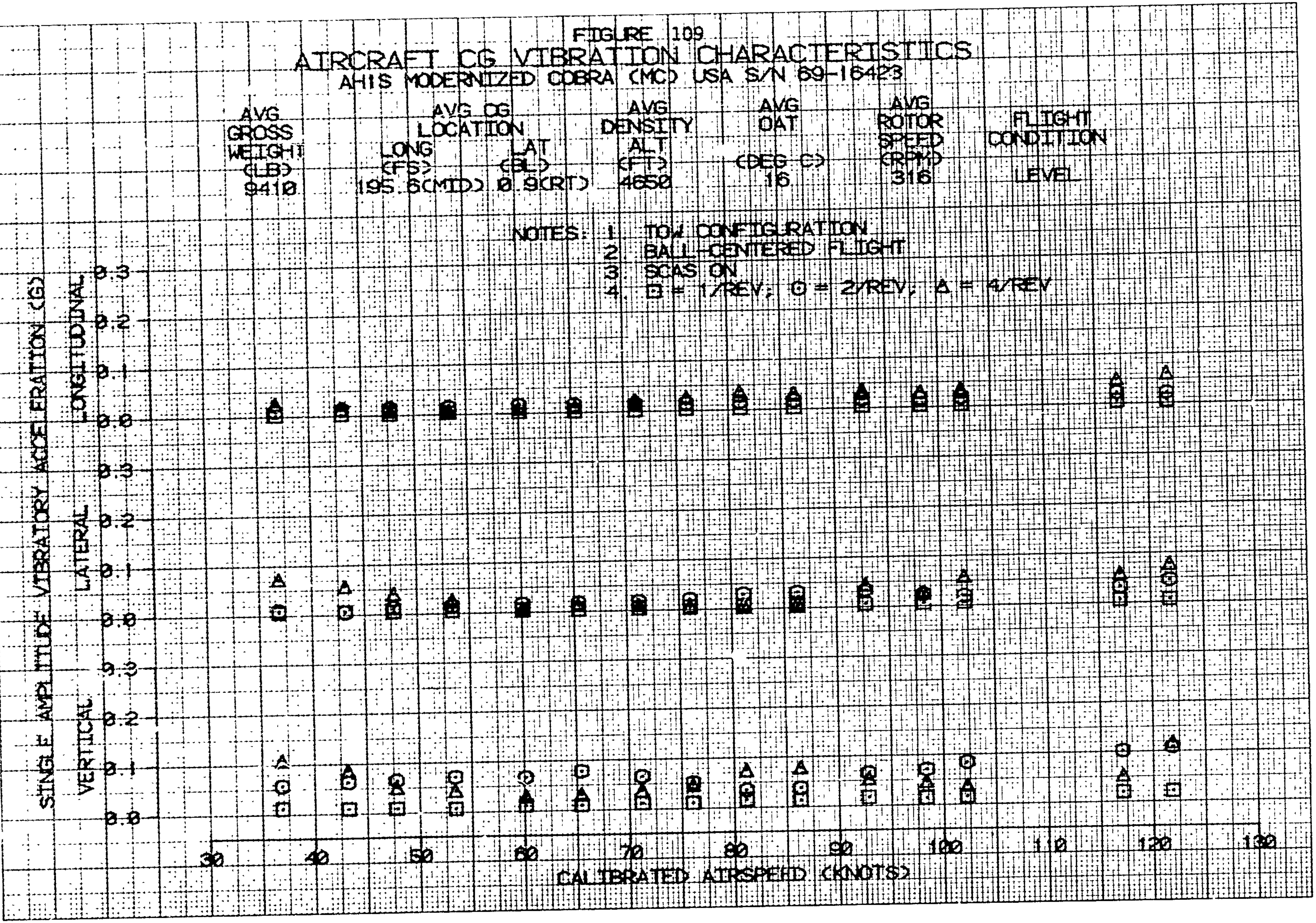


FIGURE 109
AIRCRAFT CG VIBRATION CHARACTERISTICS
AHIS MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9410
AVG CG LOCATION LONG (FS) 195.6(MID) LAT (BL) 0.9(RT)
AVG DENSITY ALT (FT) 4650
AVG OAT (DEG C) 16
AVG ROTOR SPEED (RPM) 316
FLIGHT CONDITION LEVEL
NOTES: 1. TOW CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; ○ = 2/REV; △ = 4/REV
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.3
0.2
0.1
0.0
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

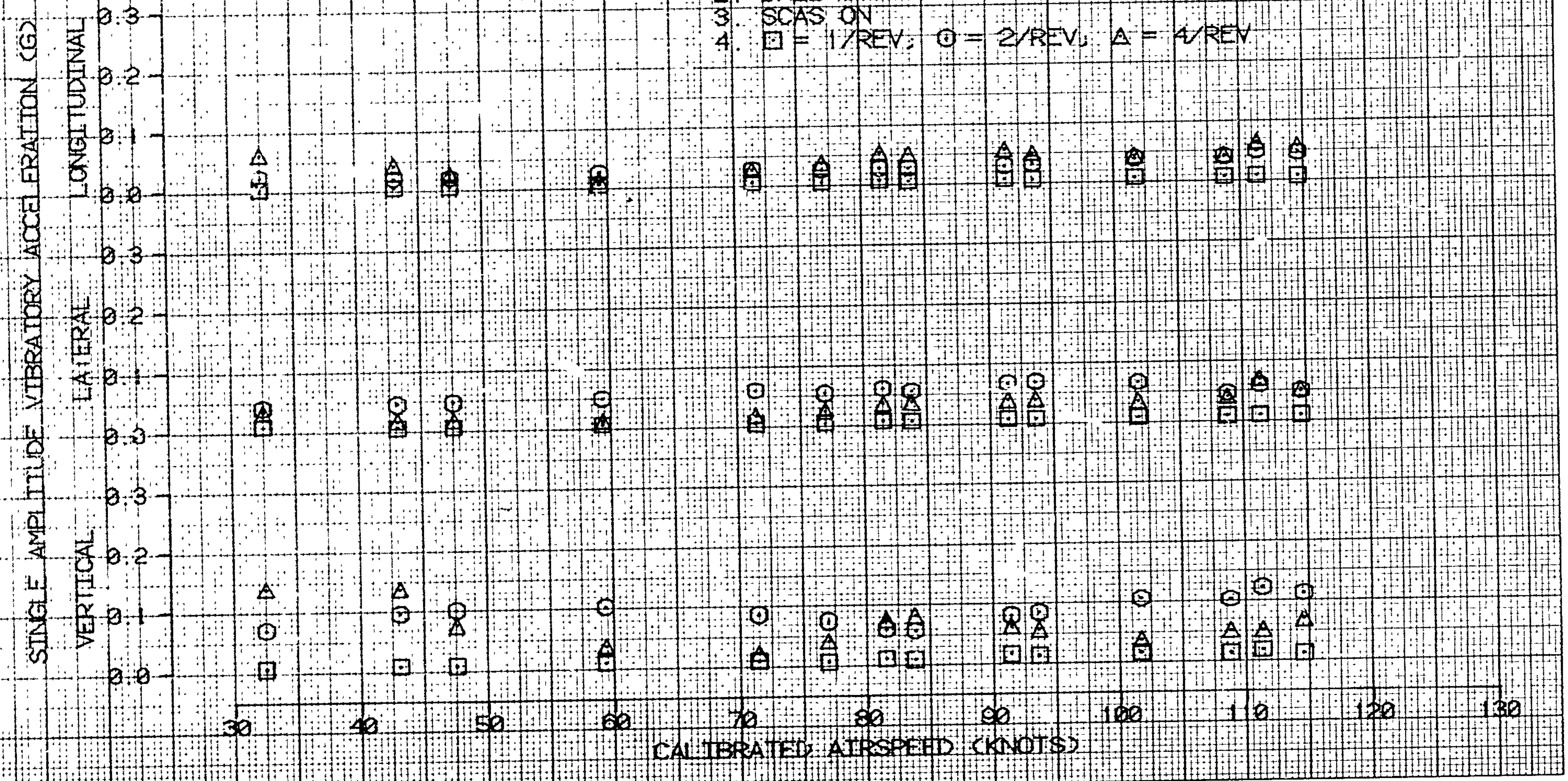
FIGURE 110

# AIRCRAFT CG VIBRATION CHARACTERISTICS

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423

| AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | AVG CG LOCATION LAT (BL) | AVG DENSITY ALT (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM) | FLIGHT CONDITION |
|---|---|---|---|---|---|---|
| 9580 | 193.3(MID) | 2.5(LT) | 5860 | 15 | 317 | LEVEL |

NOTES:
1. HELLFIRE CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV, ⊙ = 2/REV, △ = 4/REV



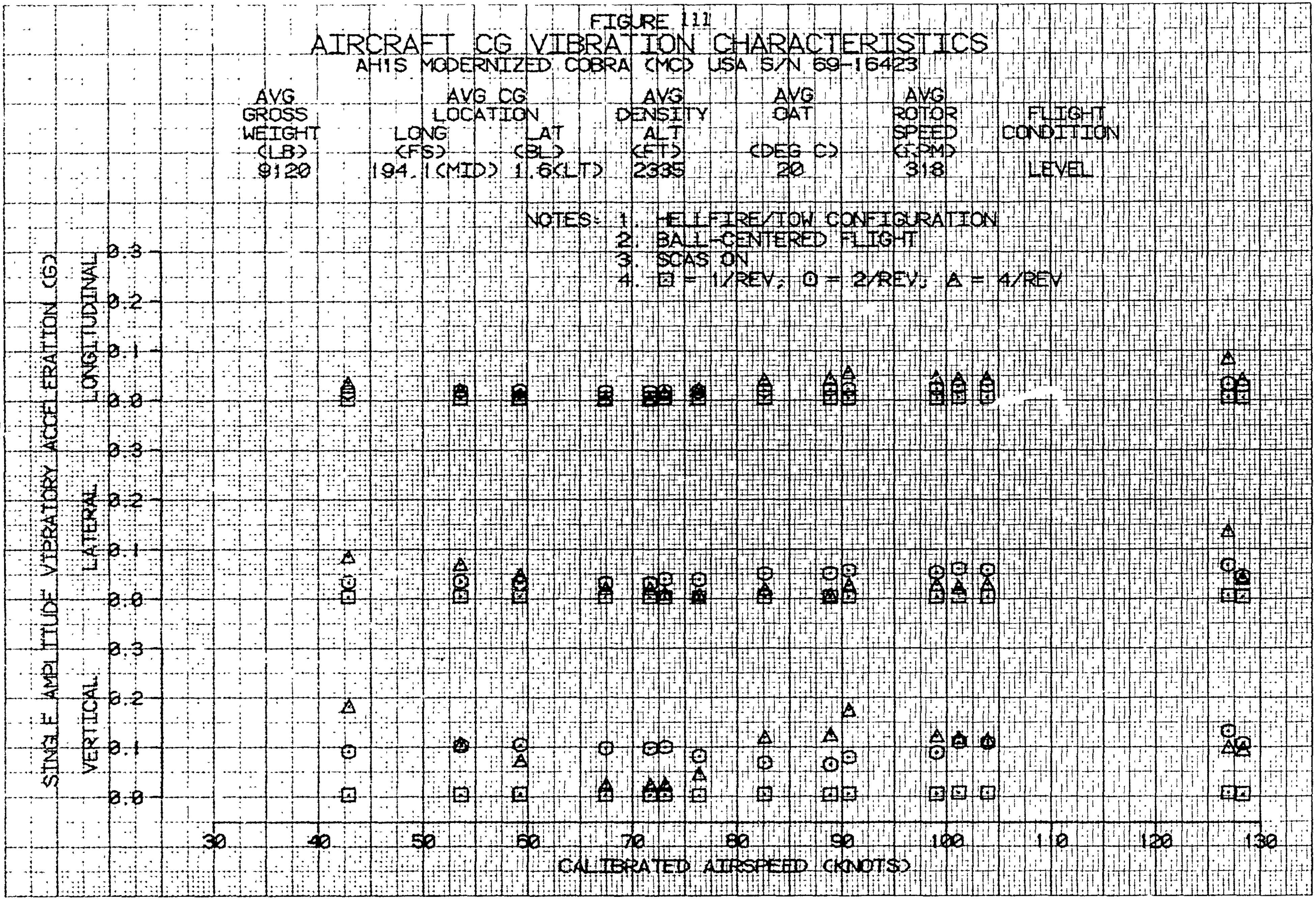
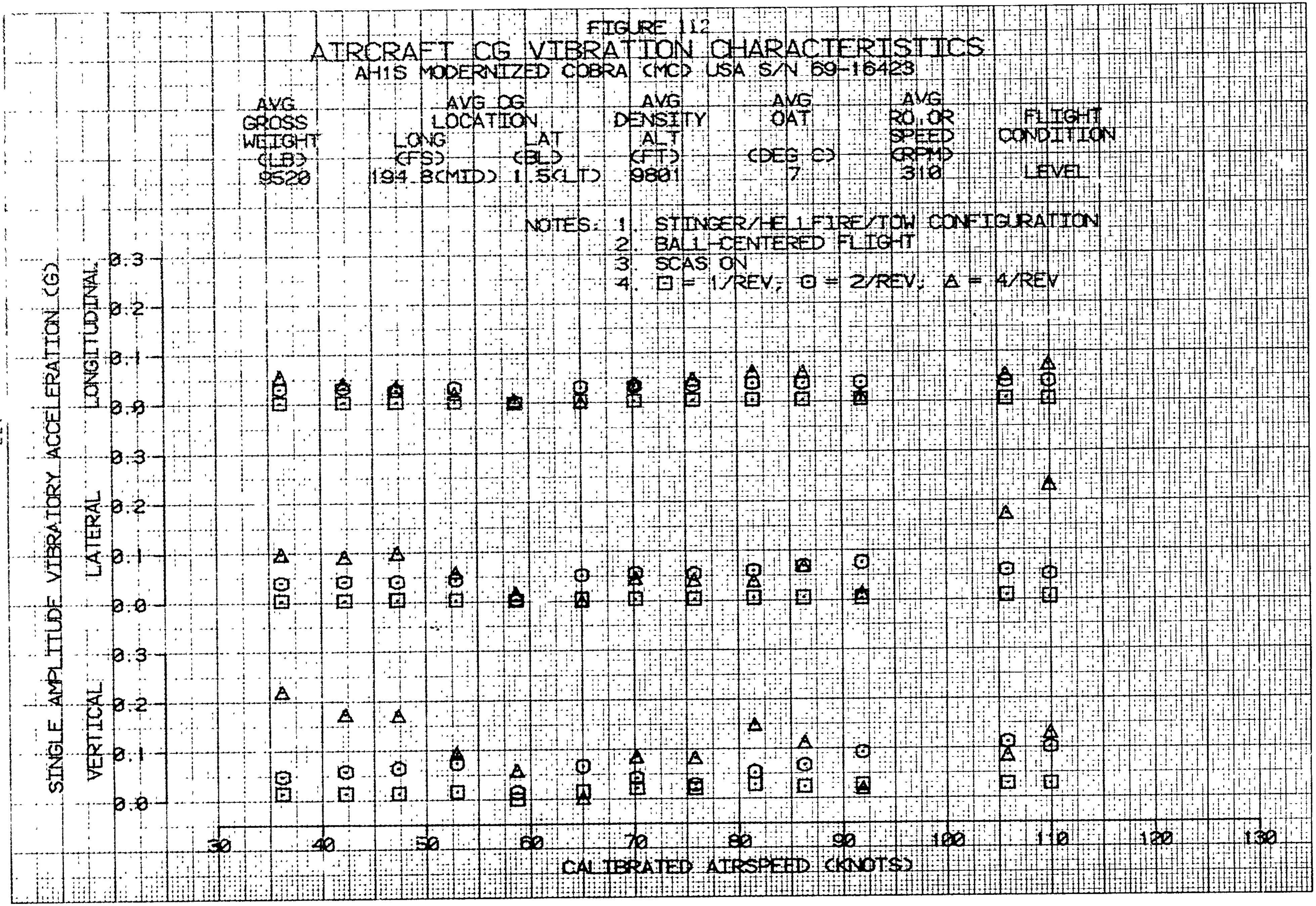


FIGURE 111
AIRCRAFT CG VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9120
AVG CG LOCATION LONG (FS) 194.1(MID)
LAT (BL) 1.6(LT)
AVG DENSITY ALT (FT) 2335
AVG OAT (DEG C) 20
AVG ROTOR SPEED (RPM) 318
FLIGHT CONDITION LEVEL
NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; ○ = 2/REV; △ = 4/REV
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
LONGITUDINAL
LATERAL
VERTICAL
0.0
0.1
0.2
0.3
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

FIGURE 112

AIRCRAFT CG VIBRATION CHARACTERISTICS

AH1S MODERNIZED COBRA (MC) USA S/N 69-16423



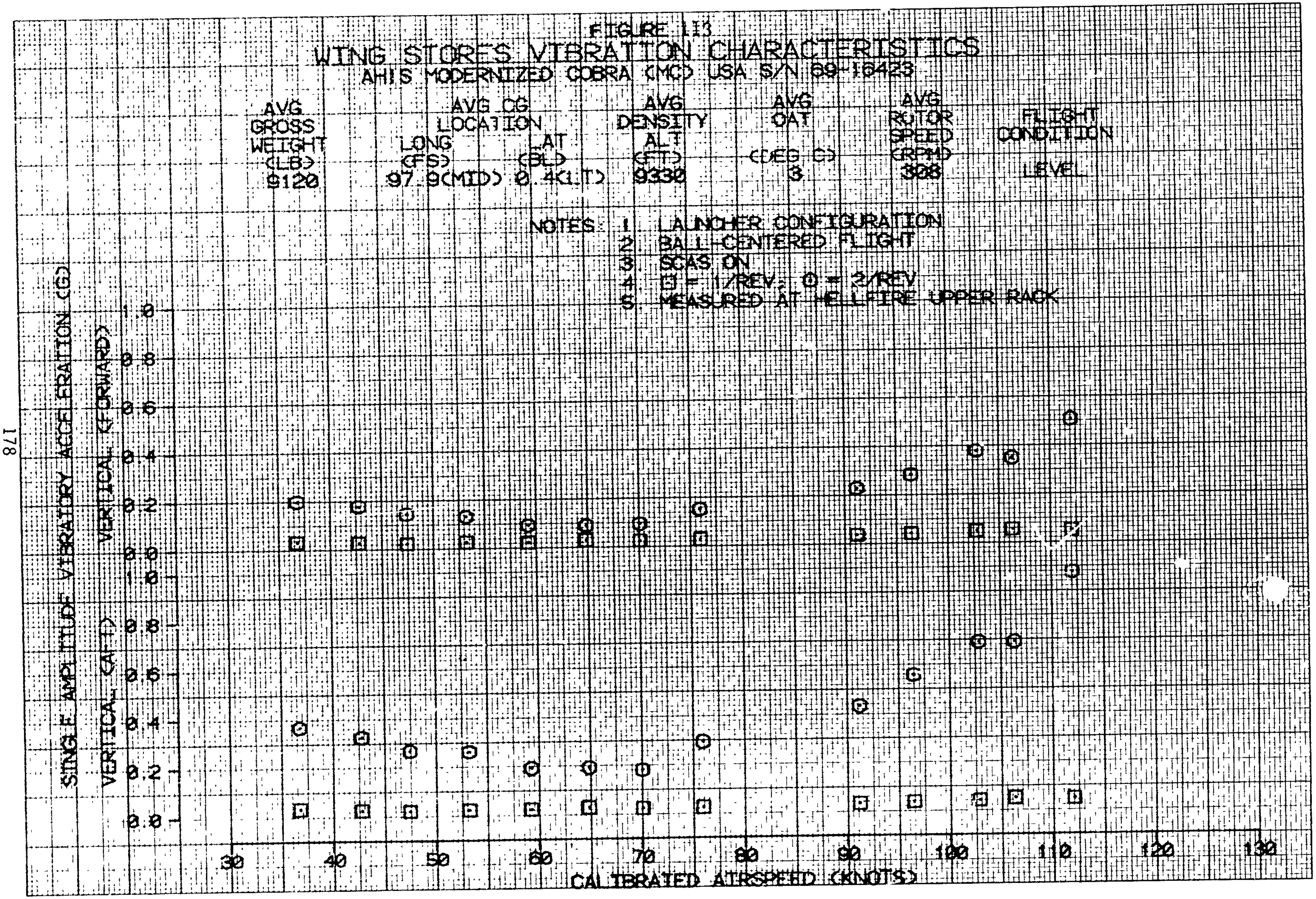
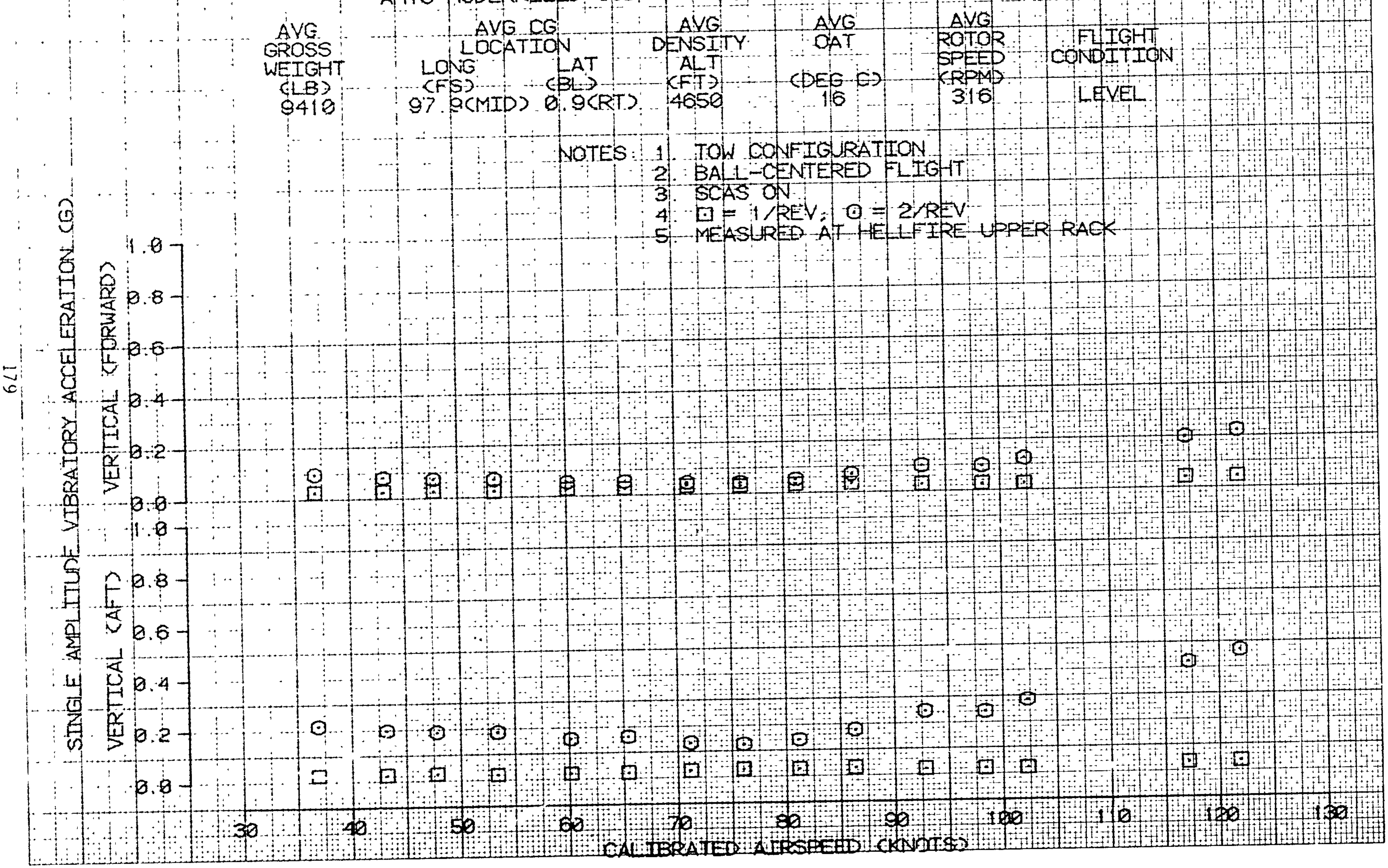



FIGURE 113
WING STORES VIBRATION CHARACTERISTICS
AHIS MODERNIZED COBRA (MC) USA S/N 69-16423

FIGURE 114
WING STORES VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423



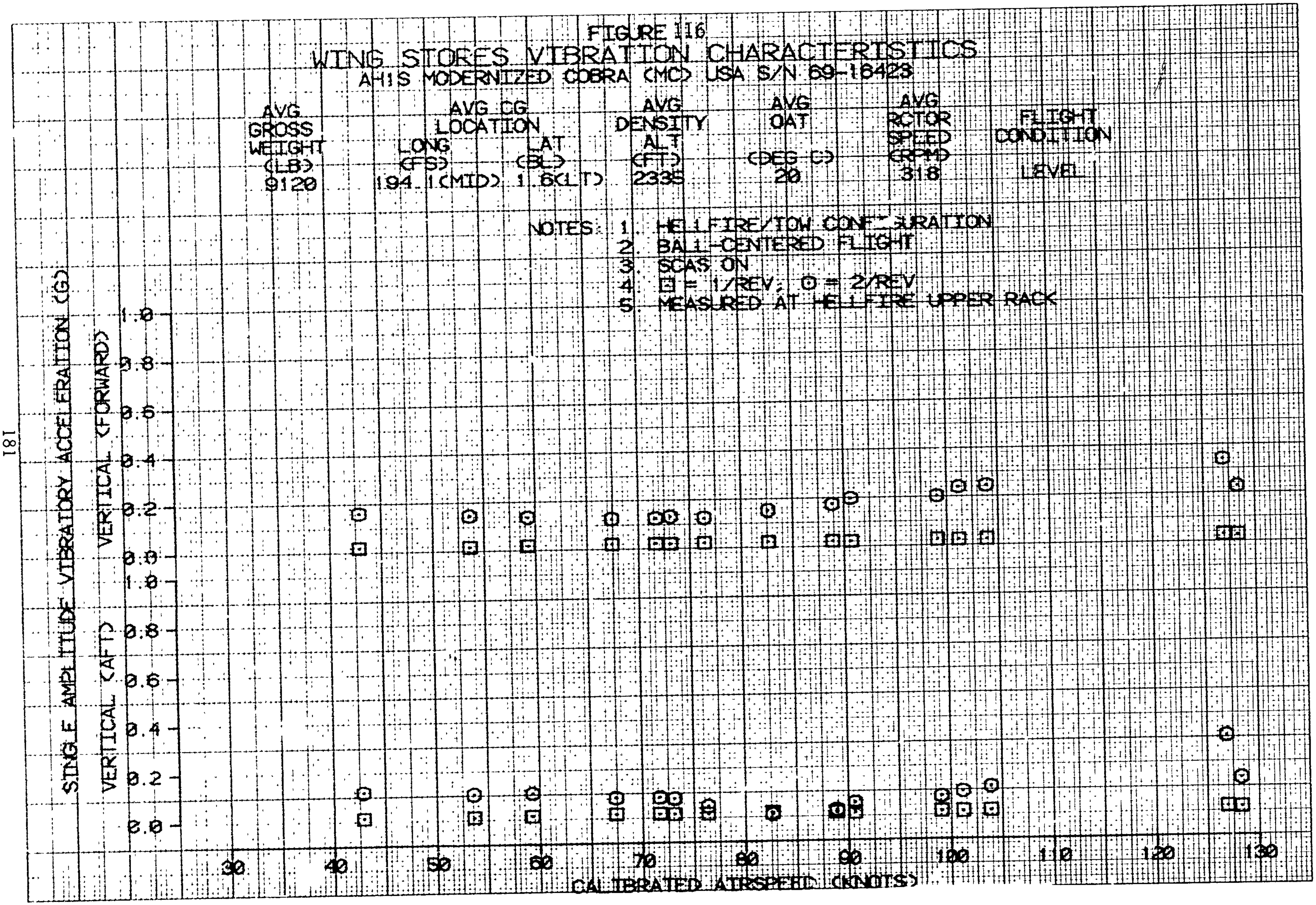
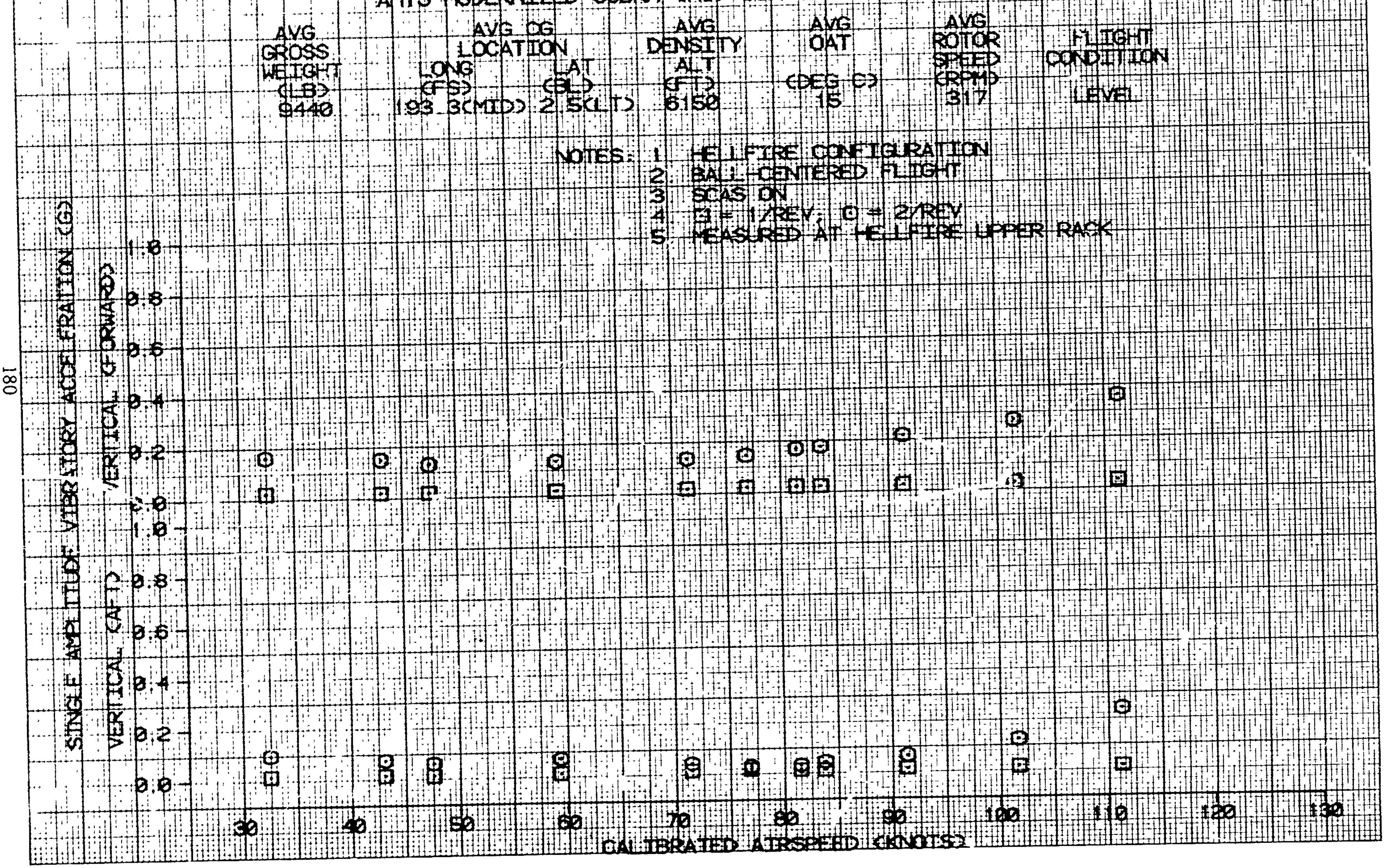


FIGURE 116
WING STORES VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423
AVG GROSS WEIGHT (LB) 9120
AVG CG LOCATION LONG (FS) 194.1(MID) LAT (BL) 1.6(LT)
AVG DENSITY ALT (FT) 2335
AVG OAT (DEG C) 20
AVG ROTOR SPEED (RPM) 318
FLIGHT CONDITION LEVEL
NOTES: 1. HELLFIRE/TOW CONFIGURATION
2. BALL-CENTERED FLIGHT
3. SCAS ON
4. □ = 1/REV; ⊙ = 2/REV
5. MEASURED AT HELLFIRE UPPER RACK
SINGLE AMPLITUDE VIBRATORY ACCELERATION (G)
VERTICAL (FORWARD)
VERTICAL (AFT)
1.0
0.8
0.6
0.4
0.2
0.0
30
40
50
60
70
80
90
100
110
120
130
CALIBRATED AIRSPEED (KNOTS)

FIGURE 115
WING STORES VIBRATION CHARACTERISTICS
AH1S MODERNIZED COBRA (MC) USA S/N 69-16423



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